

**PRODUCTION OF ETHANOL FROM BIOMASS ENGINEERING STUDY  
MATERIALS OF CONSTRUCTION OPTIONS FOR LARGE  
FERMENTATION VESSELS**

**SUBCONTRACT NO. TZ-2-12015-1**

**FOR**

**MIDWEST RESEARCH INSTITUTE AND  
NATIONAL RENEWABLE ENERGY LABORATORY  
GOLDEN, CO 80401**

**BY**

**UNITED ENGINEERS AND CONSTRUCTORS, INC.  
WESTERN OPERATIONS  
DENVER, CO 80217**

**MAY, 1992**

**FINAL**

**VOLUME III OF III**

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### VOLUME III OF III

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NREL  
MAY, 1992  
#TZ-2-12015-1

## APPENDIX A-10

### CLEANING SYSTEM VENDOR INFORMATION



**TOFTEJORG, Inc.**

March 3, 1992 - Tuesday

Via Fax Transmission and Post  
(303) 843-2208  
Page 1 of 6

United Engineers & Constructors, Inc.  
P. O. Box 5888  
Denver, CO 80217  
USA

Company Profile No.: 9128

Attention: Mr. Myron Schultz

Reference: Toftejorg Tank Cleaning Equipment & Systems  
Quotation No.: 2263

Dear Mr. Schultz:

Thank you for your interest in our products. Our commercial proposal is enclosed for your review. I have also enclosed under a separate cover one of our catalogs on the retractasystem for your information and review.

Should you have any questions, please do not hesitate to contact us.

Best regards,

Toftejorg, Inc.

Jackie Heidaker  
Sales Coordinator

/jlh  
Enclosures

cc: Toftejorg, Inc.  
Troy R. Humphries

**TOFTEJORG, INC.**



Office: (713) 487-7851  
Fax: (713) 487-7937  
Telex: 362102 TOFTE HOU

2614 East Beltway Eight  
Pasadena, Texas 77503

To:

United Engineers & Constructors, Inc.  
P. O. Box 5888

Denver

Country: USA

Attn: Mr. Myron Schultz

Zip Code: 80217

CO

Postal Code: 802

Quote No.: 2263

Our Reference : As above  
Validity : 30 Days

Date: 03-03-92

Page 1 of 1

**TERMS AND CONDITIONS OF SALE**

Payment Terms : Net 30 Days; Subject to credit approvals where applicable  
Freight Terms : FOB: Toftejorg, Inc.; Pasadena, Texas; USA  
Shipment : Stock; Subject to prior sale

Confirm Via : Telefax Transmission (303) 843-2208

Company Profile No.: 9128		Phone No.: (303) 758-1122		Region: 1	Market Code: IL	Rep/Dealer: None	Toftejong Salesman: TRH	
#	Quantity	Part Number	Description				USD Unit Net Price	USD Extension Net Price
A	1	5669	Industrial RetractsSystem - Pneumatic Actuation TZ-67 Tank Cleaning Machine; 316L S/S.				47,079.51	47,079.51
B	1	21C100					2,727.95	2,727.95

*[Handwritten signature]*

Comments: Data sheets attached for reference. Design specifications for RETRACTASystem can vary depending on customers needs. ORIGINAL

Page Total 49,807.46  
Grand Total 49,807.46

FROM: MYRON SCHULTZ  
PHONE: 303-843-2454  
FAX: 303-843-2208



MAILED 3-3-92  
TOFTEJORG, Inc.

## QUESTIONNAIRE FOR TANK CLEANING AND EQUIPMENT RECOMMENDATION

Date Received: \_\_\_\_\_ TCQ Number: \_\_\_\_\_ Last Update: \_\_\_\_\_

Company : UNITED ENGINEERS & CONSTRUCTORS Comp. Profile No. : \_\_\_\_\_  
Address : P.O. Box 5888 Contact Profile No. : \_\_\_\_\_  
Contact: MYRON SCHULTZ  
Position: MECH. ENGINEER  
City : DENVER Telephone: 303-843-2454  
State/Province : CO Telefax: 303-843-2208  
Zip Code : 80217 Postal Code: \_\_\_\_\_ Telex: \_\_\_\_\_  
Country : \_\_\_\_\_ Market Segment: \_\_\_\_\_  
Region : \_\_\_\_\_ Project No.: 6299001

### SALES AND TECHNICAL RESPONSIBILITY

Dealer/Representative: \_\_\_\_\_ Comp. Profile No.: \_\_\_\_\_  
Location of the Dealer: \_\_\_\_\_  
Dealer Salesman: \_\_\_\_\_ Cont. Profile No.: \_\_\_\_\_  
Toftejorg Salesman: \_\_\_\_\_ Salesman No.: \_\_\_\_\_

### EQUIPMENT TO BE CLEANED

- A.) Customer's name of the tank/vessel to be cleaned: ETHANOL FERMENTATION TANK
- B.) Dimensions and function of the tank or vessel in question (Attach drawing if possible):  
SEE ATTACHED DRAWINGS
- C.) Surfaces to be cleaned. Describe the composition of the tank/vessel surfaces:  
EPOXY LINED CARBON STEEL, OR T316 CLAD CARBON STEEL
- D.) New construction or existing equipment: NEW CONSTRUCTION
- E.) Quantity of tanks/vessels of this type to be considered: SEE ATTACHED DRAWINGS
- F.) Do conditions require sanitary equipment: YES
- G.) What tank/vessel openings are available for the installation of Toftejorg equipment: AS REQ'D. FOR EQUIPMENT.
- H.) Is 100% cleanliness of the subject tank/vessel required (If no, what is acceptable):  
2, YES
- I.) What percentage of shielded areas (areas that cannot be impinged upon by direct contact of the jet length) are acceptable: ASSUME NO SHIELDED AREAS



TOFTEJORG, Inc.

## PRESENT METHOD OF CLEANING

## A. PRESENT PRACTICE:

☒ None: \_\_\_\_\_ Manual: \_\_\_\_\_ Flotation: \_\_\_\_\_ Competitive Manufacturer: \_\_\_\_\_

Comments: NEW CONSTRUCTION

## B.) FREQUENCY OF CLEANING: \_\_\_\_\_

## C.) PRESENT CLEANING TIME: \_\_\_\_\_

## D. REASON FOR CLEANING

To achieve sterility : ✓ Prevent cross contamination : \_\_\_\_\_

Improve heat transfer : \_\_\_\_\_ Sludge/sediment removal : ✓ ✓

Preparation for maintenance or inspection: ✓

Comments: TANKS CANNOT BE ENTERED UNLESS STERILIZED & FLUSHED; EACH TANK WILL REQUIRE ITS OWN FIXED, SELF CONTAINED SYSTEM.

E.) FIXED OR PORTABLE APPLICATION: FIXED

F.) DESIRED CLEANING TIME: CAN GO TO 6 HOURS

## TYPE OF SOILAGE

<input type="checkbox"/> Hydrocarbon	<input type="checkbox"/> Volatile/explosive	<input type="checkbox"/> Sticky/tenacious
<input checked="" type="checkbox"/> Chemical	<input checked="" type="checkbox"/> Hard/crusted	<input checked="" type="checkbox"/> Organic
<input type="checkbox"/> Toxic	<input checked="" type="checkbox"/> Soft/soluble	<input type="checkbox"/> Inorganic

Name of the material to be removed from the subject tank/vessel. BACTERIOLOGICAL SLUDGE/SEDIMENT SAWDUST + SLUDGE.

What is the material soluble in. \_\_\_\_\_

## BUDGET CONSIDERATIONS

What are the cost expectations/limitations: THIS ESTIMATE IS TO BE FOR BUDGET PURPOSES ONLY, (±25%) A PILOT PLANT IS BEING ENGINEERED & CONSTRUCTED TO PROVE THE PROCESS & DETERMINE MATERIALS & EQUIPMENT FOR A FULL SCALE PLANT.



TOFTEJORG, Inc.

## CURRENT OR AVAILABLE OPERATING PARAMETERS

## A.) SUPPLY PRESSURE

A1.) At Pump

AS REQ'D.

A2.) At Current Cleaning Device

N/A

## C.) FLOW RATE

C1.) At Supply Pump

AS REQ'D.

C2.) At Current Cleaning Device

N/A

C3.) At Suction Side of Tank

## B.) CONVEYANT

TREATED WATER

## D.) CONVEYANT TEMPERATURE:

150°F

## E.) TYPE OF VALVE

AS REQ'D.F.) STEAM INJECTION: NO

## ADDITIONAL INFORMATION

Is a complete CIP system required: YES.Comments: IT IS EXPECTED THAT THE C.I.P. SYSTEM CLEANING CYCLE WILL CONSIST OF THE FOLLOWING STEPS:

- 1) SPRAY TO SCRUB SOLID DEPOSITS FROM ALL INTERIOR SURFACES. (150°F WATER)
- 2) SPRAY TO FLUSH ALL SOLIDS FROM THE TANK. (150°F WATER)
- 3) SPRAY TO CLEAN AND SANITIZE INTERIOR SURFACES (150°F NaOH)
- 4) SPRAY TO FLUSH NaOH SOLUTION (150°F WATER)
- 5) SPRAY TO STERILIZE ALL INTERIOR SURFACES (? STERILIZER)
- 6) SPRAY TO FLUSH STERILIZER

## FOR DEMONSTRATION PURPOSES ONLY

Should the demonstration of our products meet your requirements, will a purchase be made within 30 days of test termination? If no, give explanation:

**TOFTEJORG, Inc.****CUSTOMER'S EXPECTATIONS**

Describe your requirements of our equipment and your primary points of interest. What are your desired results?

IT IS EXPECTED THAT THE MOST DIFFICULT PART OF THE CLEANING CYCLE WILL BE TO FLUSH THE SOLIDS THAT COLLECT ON THE SLOPED FLOOR, ACROSS THE FLOOR AND OUT OF THE TANK. THE FLOOR WILL BE SLOPED SUFFICIENTLY TO DRAIN LIQUIDS, BUT NOT TO ENTRAIN WET SAWDUST. THE SLUDGE ON THE FLOOR WILL HAVE TO BE IMPACTED BY A WATER JET TO GET IT TO MOVE.

**TECHNICAL RECOMMENDATION OF EQUIPMENT AND COMMENTS**

A RECOMMENDATION FOR EQUIPMENT, AND A BUDGET COST ESTIMATE IS REQ'D.

**INFORMATION OBTAINED BY:****EVALUATION BY:**

**TOFTEJORG, Inc.**

REFER TO MESSAGE NO.

SENT

March 19, 1992 - Thursday

Via Fax Transmission and Post **MAR 19 1992**

(303) 843-2208

Page 1 of 10

ANS'D. BY

United Engineers & Constructors, Inc.  
P. O. Box 5888  
Denver, CO 80217  
USA

Company Profile No.: 9128

Attention: Mr. Myron Schultz

Reference: Toftejorg Tank Cleaning Equipment & Systems  
Quotation No.: 2308  
Tank Cleaning Questionnaire No.'s: 449, 450, and 451

Dear Mr. Schultz:

Thank you for your interest in our products. Our commercial and technical proposals are enclosed for your review.

Should you have any questions, please do not hesitate to contact us.

Best regards,

Toftejorg, Inc.

Jackie Heldaker  
Sales Coordinator

/j/h  
Enclosures

cc: Toftejorg, Inc.  
Troy R. Humphries

**Comments:**

**COPIES &**

**TOFTEJORG, Inc.****TECHNICAL RECOMMENDATION OF TOFTEJORG TANK CLEANING EQUIPMENT  
AND SYSTEMS****Tank Cleaning Questionnaire Number: 449****Date of Recommendation: 03-17-92****Company: United Engineers & Constructors, Inc.  
Comp. Profile No: 9128****Contact: Myron Schultz  
Contact Profile No: 7591****Evaluated by: Theron Tindall****CUSTOMERS NAME OF TANK/VESSEL: Ethanol Fermentation Tank****PRODUCT SPECIFICATIONS: 01) Tank Cleaning Machine(s)**

A) Model	: TZ-75
B) Article number	: 1205
C) Nozzle configuration	: Two 13mm
D) Recommended pressure @ machine this case	: 100 PSIG
E) Recommended flow rate @ machine this case	: 130 GPM
F) Maximum horizontal jet length	: 103'
G) Effective horizontal jet length	: 62'
H) Time to establish one complete cleaning pattern	: 42 minutes
I) Number of cycles to establish one pattern	: 4
J) Time to establish one cycle	: 10.5 minutes
K) Track width after pattern established @ 38'	: 24"
L) Axial RPM of machine	: 1
M) Inlet connection on machine	: 2" NPT (M)
N) Peripheral jet speed @ 38'	: 5.6 feet/second
O) Installation drawing number	: DWG0420
P) Quantity of machines per tank/vessel	: 1
Q) Number of vessels this case	: 84
R) Total number of machines required this case	: 84

**02) Installation Assembly**

A) Installation drawing number	: DWG0420
B) Quantity required	: 84
C) Part number	: 5870



# INSTALLATION DRAWING

DRAWING NO.: DWG0420

REVISION :

APPLICATION: PROCESS

QTY: 84

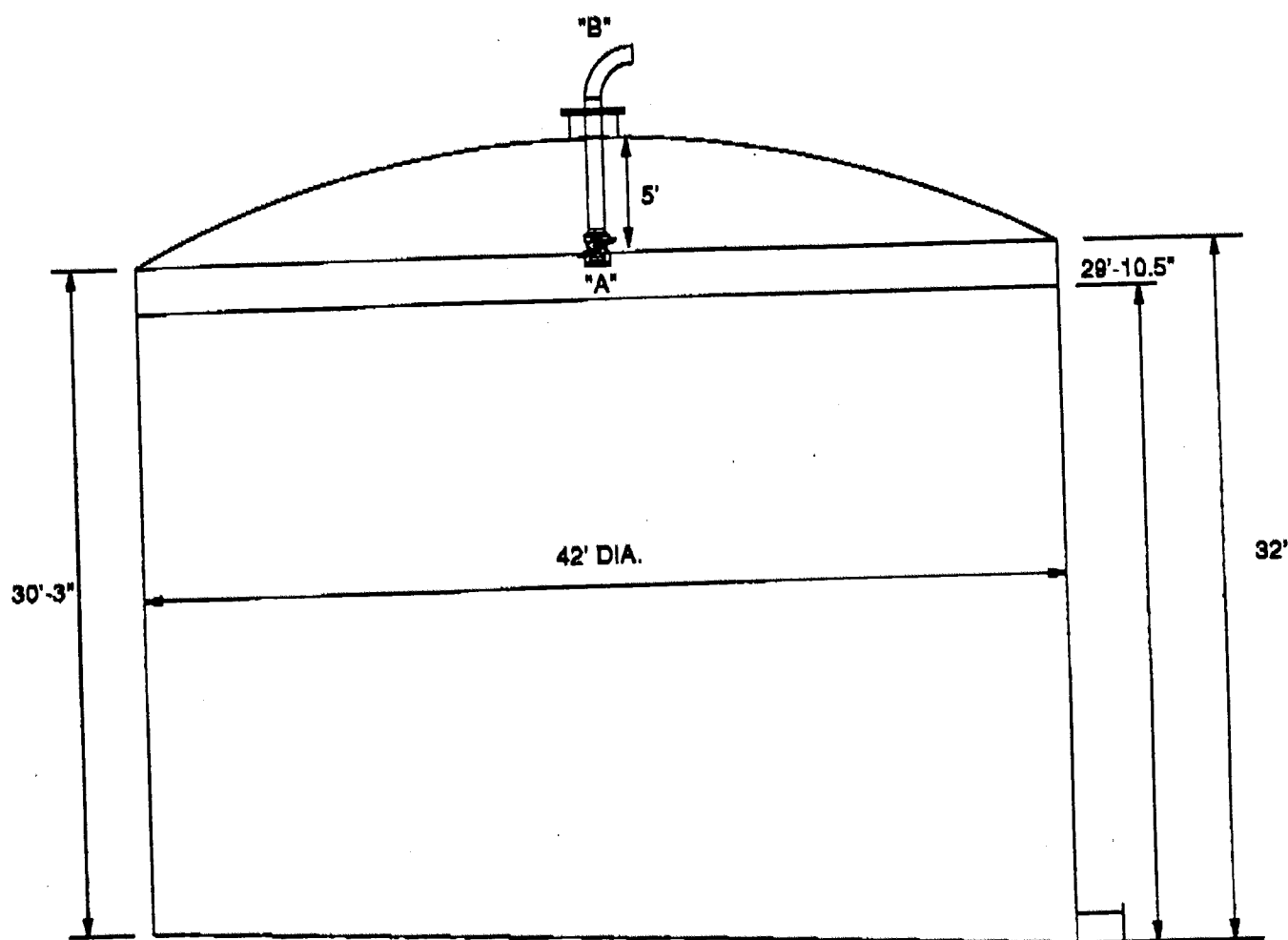
CUSTOMER: UNITED ENGINEERS &amp; CONSTRUCTORS, INC.

TCQ #: 449

PROFILE #: 9128

DESCRIPTION: ETHANOL FERMENTER T-100

MARKET SEGMENT: IL



REF	MODEL	ARTICLE NO.	QTY	PRESSURE	FLOW	This drawing is the property of TOFTEJORG and must not be copied, handed or otherwise disposed to any third party without our written permission.	
A	TZ-75	1206	1	100 PSIG	130 GPM	Drawn: TWT	Date: 03-18-92
B	INSTALLATION ASSEMBLY		1			Scale: 1/100	Project No.: NONE

TOFTEJORG, INC.  
Tofte & Jorgensen3914 East Belvoir Blvd.  
Tomball, Texas 77451  
USATel: (713) 487-7837  
Fax: (713) 487-7837  
Telex: 343123 TOFTEJ

**TOFTEJORG, Inc.****TECHNICAL RECOMMENDATION OF TOFTEJORG TANK CLEANING EQUIPMENT  
AND SYSTEMS****Tank Cleaning Questionnaire Number: 450****Date of Recommendation: 03-17-92****Company: United Engineers & Constructors, Inc.  
Comp. Profile No: 9128****Contact: Myron Schultz  
Contact Profile No: 7591****Evaluated by: Theron Tindall****CUSTOMERS NAME OF TANK/VESSEL: Ethanol Fermentation Tank****PRODUCT SPECIFICATIONS: 01) Tank Cleaning Machine(s)**

A) Model	: T2-75
B) Article number	: 1206
C) Nozzle configuration	: Two 13mm
D) Recommended pressure @ machine this case	: 100 PSIG
E) Recommended flow rate @ machine this case	: 130 GPM
F) Maximum horizontal jet length	: 103'
G) Effective horizontal jet length	: 62'
H) Time to establish one complete cleaning pattern	: 52 minutes
I) Number of cycles to establish one pattern	: 4
J) Time to establish one cycle	: 13 minutes
K) Track width after pattern established @ 50'	: 31"
L) Axial RPM of machine	: 0.85
M) Inlet connection on machine	: 2" NPT(M)
N) Peripheral jet speed @ 50'	: 6.3 feet/second
O) Installation drawing number	: DWG0421
P) Quantity of machines per tank/vessel	: 1
Q) Number of vessels this case	: 34
R) Total number of machines required this case	: 34

**Installation Assembly**

A) Installation drawing number	: DWG0421
B) Quantity required	: 34
C) Part number	: 5871



# INSTALLATION DRAWING

DRAWING NO.: DWG0421

REVISION :

APPLICATION: PROCESS

QTY: 34

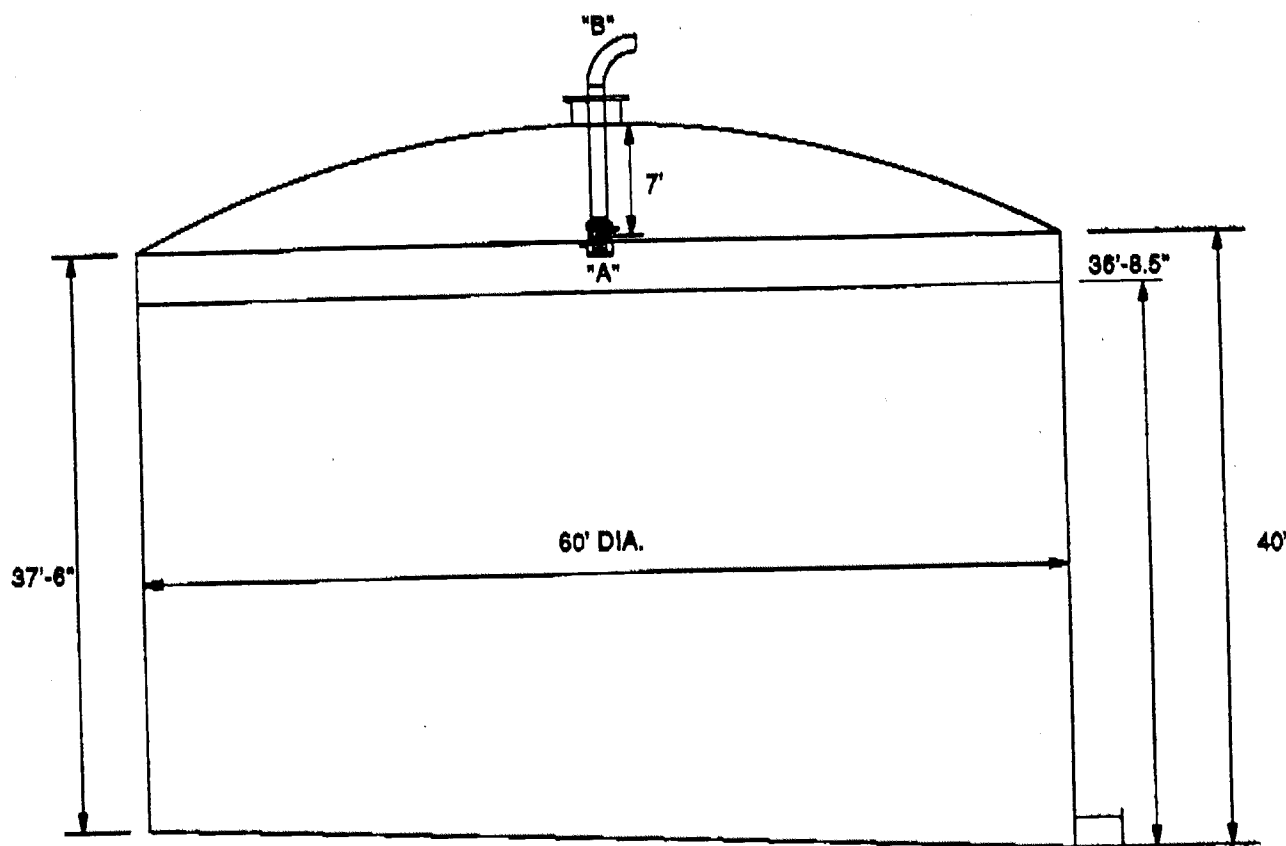
CUSTOMER: UNITED ENGINEERS &amp; CONSTRUCTORS, INC.

TCQ #: 450

PROFILE #: 8128

DESCRIPTION: ETHANOL FERMENTER T-200

MARKET SEGMENT: IL



REF	MODEL	ARTICLE NO.	QTY	PRESSURE	FLOW	This drawing is the property of TOFTEJORG and must not be copied, handled or otherwise dispatched to any third party without our written permission.	
A	TZ-75	1206	1	100 PSIG	130 GPM	Drawn: TWT	Date: 08-16-00
B	INSTALLATION ASSEMBLY	1				Scale: 1/4"=1'	Project No.: NONE


**TOFTEJORG, INC.**  
 Tote & Jorgensen

 2114 Star Highway Blvd  
 Piquette, MI 49663  
 USA

 Phone: (713) 487-7793  
 Telex: (713) 487-7793  
 Fax: (713) 487-7793

**TOFTEJORG, Inc.****TECHNICAL RECOMMENDATION OF TOFTEJORG TANK CLEANING EQUIPMENT  
AND SYSTEMS**

Tank Cleaning Questionnaire Number: 451

Date of Recommendation: 03-17-92

Company: United Engineers & Constructors, Inc.  
Comp. Profile No: 9128Contact: Myron Schultz  
Contact Profile No: 7591

Evaluated by: Theron Tindall

**CUSTOMERS NAME OF TANK/VESSEL:** *Bhanol Fermentation Tank***PRODUCT SPECIFICATIONS:** 01) Tank Cleaning Machine(s)

A) Model	: TZ-75
B) Article number	: 1206
C) Nozzle configuration	: Two 13mm
D) Recommended pressure @ machine this case	: 100 PSIG
E) Recommended flow rate @ machine this case	: 130 GPM
F) Maximum horizontal jet length	: 103'
G) Effective horizontal jet length	: 62'
H) Time to establish one complete cleaning pattern	: 52 minutes
I) Number of cycles to establish one pattern	: 4
J) Time to establish one cycle	: 13 minutes
K) Track width after pattern established @ 58'	: 36"
L) Axial RPM of machine	: 0.85
M) Inlet connection on machine	: 2" NPT(M)
N) Peripheral jet speed @ 58'	: 7.3 feet/second
O) Installation drawing number	: DWG0422
P) Quantity of machines per tank/vessel	: 1
Q) Number of vessels this case	: 24
R) Total number of machines required this case	: 24

## 02) Installation Assembly

A) Installation drawing number	: DWG0422
B) Quantity required	: 24
C) Part number	: 5872



# INSTALLATION DRAWING

DRAWING NO.: DWG0422

REVISION :

APPLICATION: PROCESS

QTY: 24

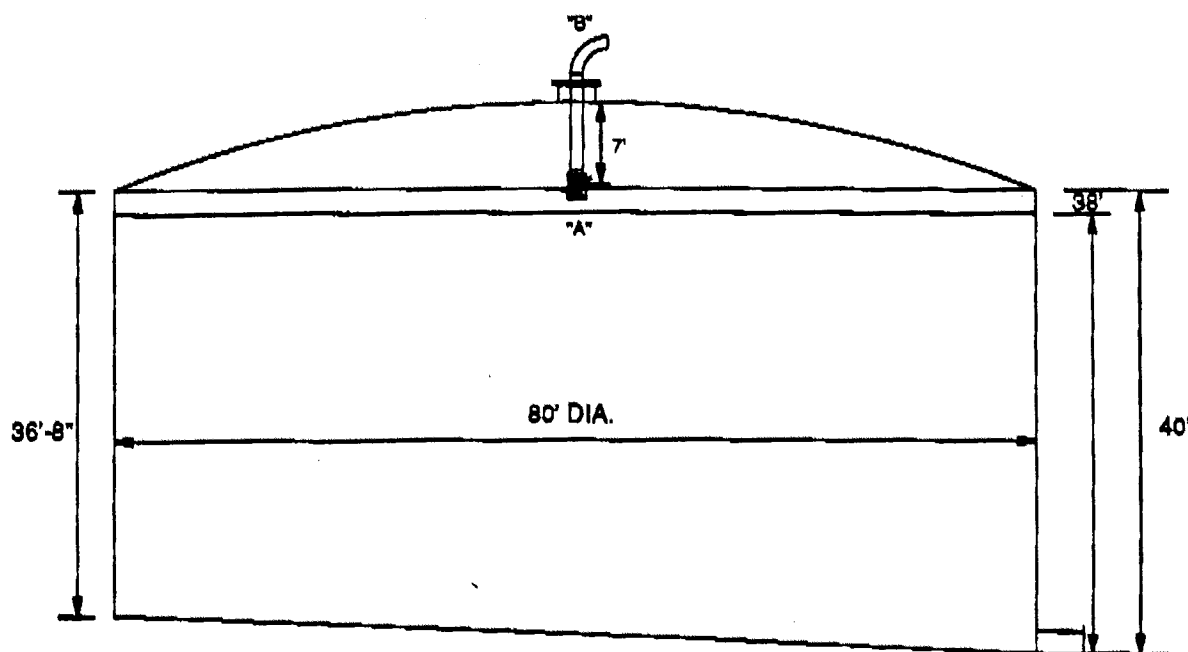
CUSTOMER: UNITED ENGINEERS &amp; CONSTRUCTORS, INC.

TCQ #: 451

PROFILE #: 9128

DESCRIPTION: ETHANOL FERMENTER T-300

MARKET SEGMENT: IL

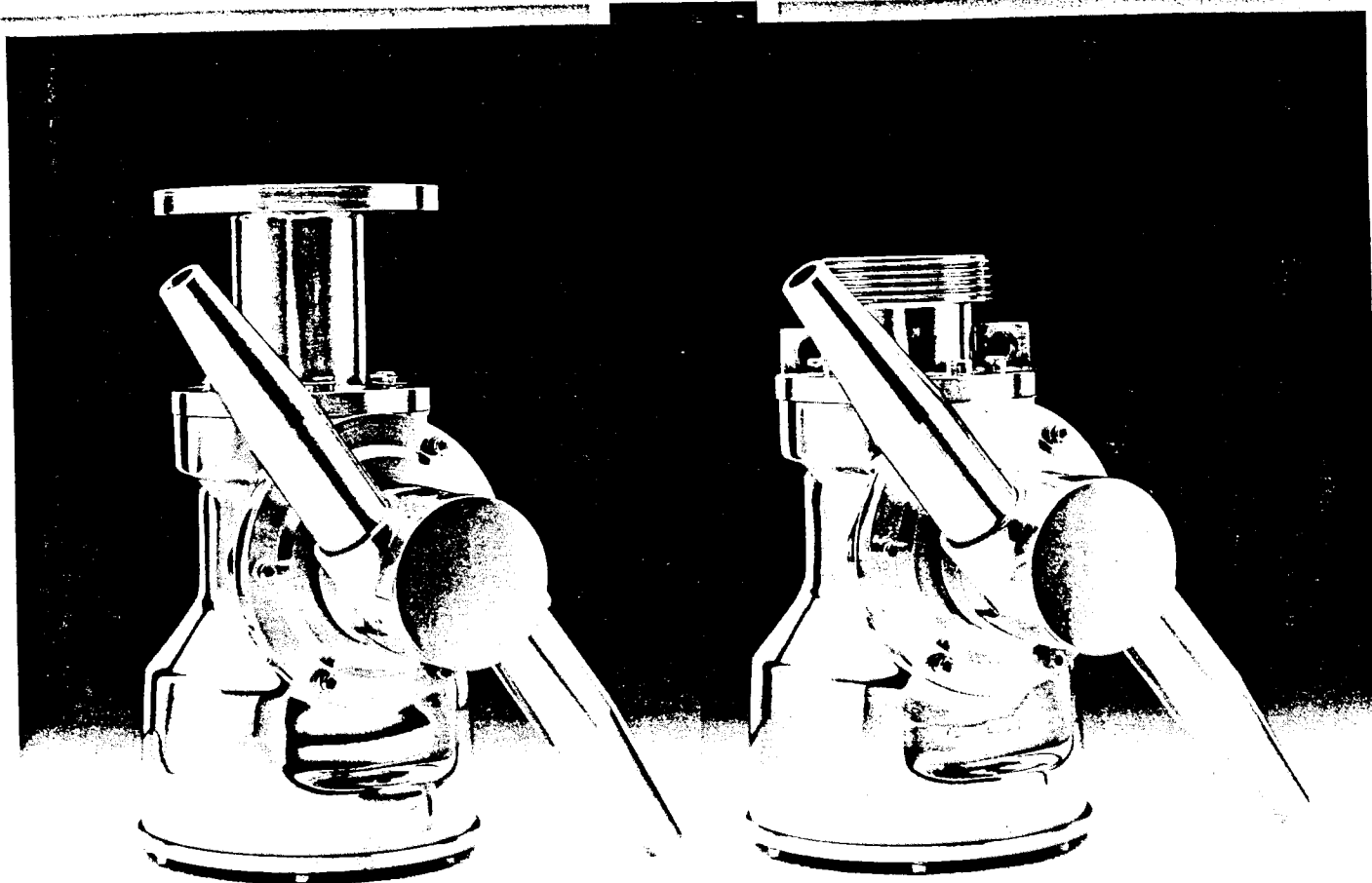


REF	MODEL	ARTICLE NO.	QTY	PRESSURE	FLOW	This drawing is the property of TOFTEJORG and must not be copied, handled or otherwise dispatched to any third party without our written permission.	
A	TZ-75	1206	1	100 PSIG	130 GPM	Drawn: TWT	Date: 06-18-92
B	INSTALLATION ASSEMBLY	1				Scale: 1/800	Project No.: NONE

**TOFTEJORG, INC.**  
Tofte & Jorgensen

8014 East Wilshire Blvd.  
Tulsa, OK 74114  
Tel: 918-487-7937  
Fax: 918-487-7938

Phone: (713) 487-7937  
Tulsa: (918) 487-7937  
Fax: (918) 487-7938



# TOFTEJORG Tank Cleaning Equipment Type TZ-75

The TOFTEJORG group has been developing, manufacturing and marketing advanced tank cleaning equipment for more than 30 years to the marine industry.

Major benefits include an optimized operational economy, reduced cleaning time and a minimal consumption of cleaning fluid and energy.

One out of three tankers in operation is equipped with TOFTEJORG tank cleaning machines.

■ **TOFTEJORG A/S**

P.O. Box 1149  
Baldershøj 19  
2635 Ishøj  
Denmark

■ **TOFTEJORG, Inc.**

2614, East Beltway Eight  
Pasadena, Texas 77503  
U.S.A.

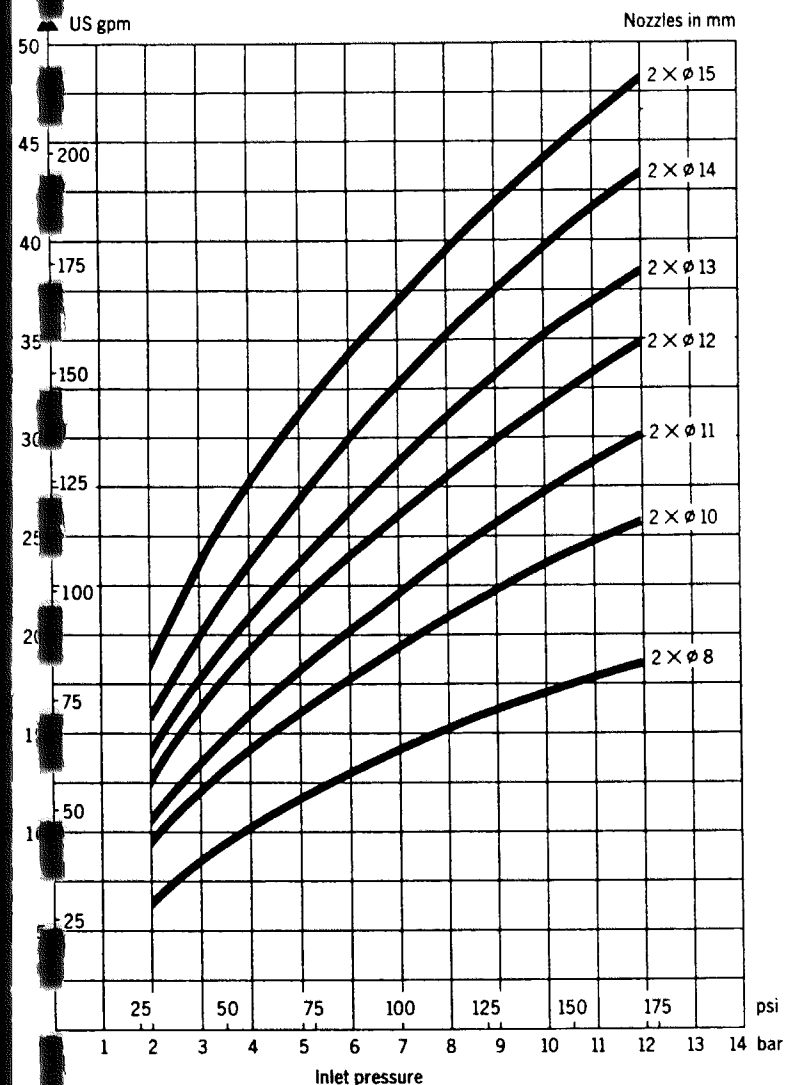
■ **TOFTEJORG GmbH**

Lindenweg 2  
2082 Tornesch  
Germany

■ **TOFTEJORG, Ltd.**

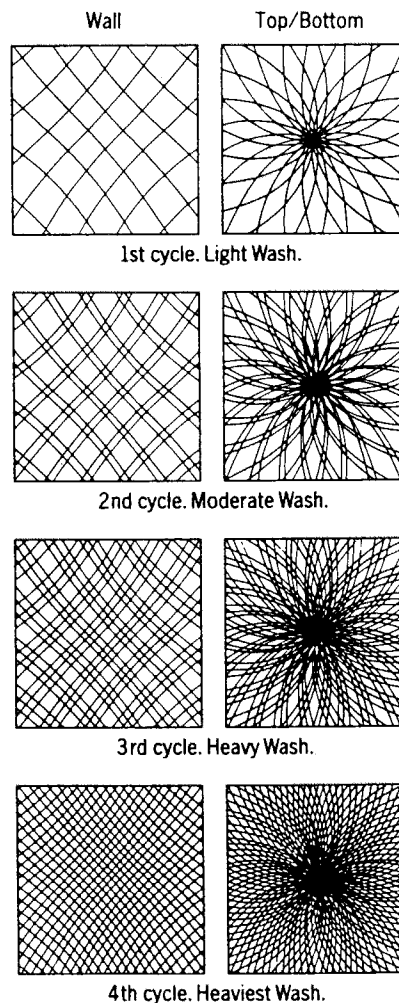
Sanderum House  
Oakley Road  
Chinnor Oxon OX9 4TW  
England

## Capacity Diagram



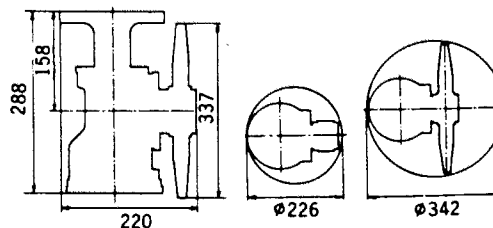
## Cleaning Pattern

A complete cleaning pattern consists of 4 individual cycles. To comply with IMO prewash requirements 1, 2 or 3 cycles can be selected, thus minimizing cleaning time and slops.

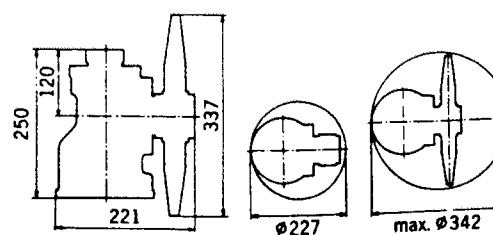


## Principal dimensions in mm

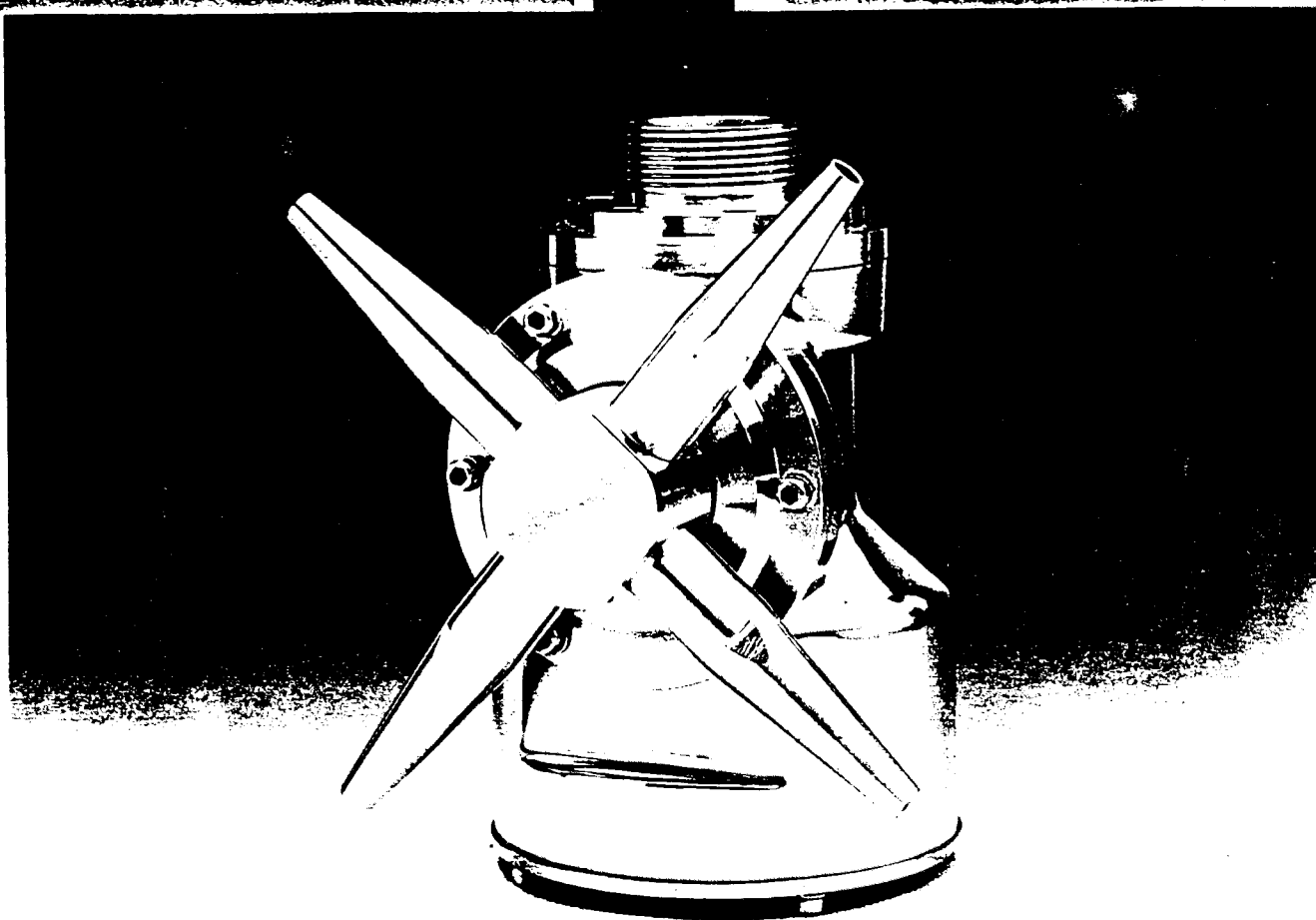
### Fixed



### Portable



Material	Stainless Steel AISI 316 L, PTFE, PVDF, Carbon
Weight	13 kgs (28,7 lb) portable model 16 kgs (35,3 lb) fixed model
Product	Selflubricating with the cleaning fluid
Working pressure	2-12 bar (30-174 psi)
Recommended inlet pressure	5-10 bar (72-145 psi)
Maximum working temperature	95°C (203°F)
Row length	Between 22 and 36 meters (72 and 118 ft.) depending on machine configuration and pressure
Cleaning time	Between 3 and 12 minutes depending on machine configuration and pressure
Installation	Fixed or portable
Connection thread	2 inch NPT or 2½ inch ASA for portable installation
Range	Ø 127 - PC 98,5 - 4 x Ø 11 mm (0,43 inch) holes
Minimum required passage	226 mm (8,90 inch) fixed model, 227 mm (8,94 inch) portable model
Regulations	The equipment fully complies with the IMO regulations and the requirements of the classification societies



# TOFTEJORG Tank Cleaning Equipment Type TZ- 67

TOFTEJORG tank cleaning machines have been developed for automatic cleaning of tanks and process vessels. They are used all over the world in a wide variety of industries, optimizing cleaning efficiency, consumption of water and energy as well as safety for personnel and environment.

■ **TOFTEJORG A/S**

P.O. Box 1149  
Baldershøj 19  
2635 Ishøj  
Denmark

Phone: +45 42 52 86 66  
Telefax: +45 42 52 75 52  
Telex: 31288 tofte dk

■ **TOFTEJORG, Inc.**

2614, East Beltway Eight  
Pasadena, Texas 77503  
U.S.A.

Phone: (713) 487-7851  
Telefax: (713) 487-7937  
Telex: 362102 tofte hou

■ **TOFTEJORG GmbH**

Lindenweg 2  
2082 Tornesch  
Germany

Phone: +49 4122 51376  
Telefax: +49 4122 55808

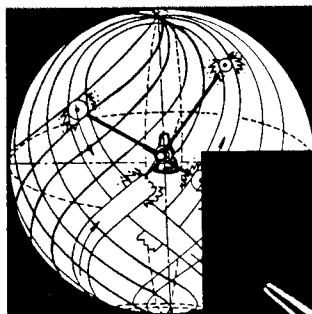
■ **TOFTEJORG, Ltd.**

Sanderum House  
Oakley Road  
Chinnor Oxon OX9 4TW  
England

Phone: +44 844 54171  
Telefax: +44 844 54144  
Telex: 837789 ajb g

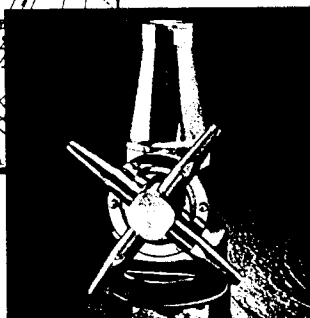
ThunderJet by Toftejorg for automatic cleaning power

## How to make your tank and vessel cleaning faster, less costly and safe.



The Toftejorg machines rotate 360° in the horizontal and 360° in the vertical planes.

The dual rotation of the jets builds up interwoven figure "8" patterns for a clean sweep of the surface.



Toftejorg automated cleaning equipment and systems outperform all non-automated cleaning methods. With the Toftejorg system, your processes are up and running faster. And, the system saves water and chemicals.

As a world leader in automated cleaning technology for over 35 years, Toftejorg will deliver:

- Reduced labor costs & hazards associated with non-automated methods, yet better cleaning quality
- Improve productivity with faster turnarounds and less contamination
- Unique rotary jet machines that are superior to static cleaning devices which can clog and leave voids.
- Both fixed and portable applications that can clean any size tank or vessel.

**Call or write Toftejorg or your local representative for a free cost/benefit analysis of your tank cleaning options**



### North America

#### Toftejorg, Inc.

2614 East Beltway Eight  
Pasadena, Texas 77503  
USA  
Phone: (713) 487-7851  
Fax: (713) 487-7937

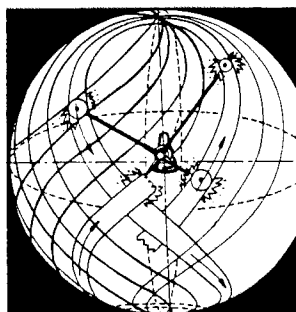
### Europe

#### Toftejorg, A/S

Box 1149  
Baldershøj 19  
2635 Ishøj, Denmark  
Phone: 45 42 52 86 66  
Fax: 45 42 52 75 52

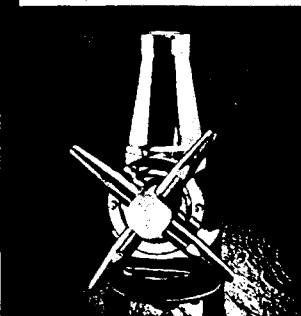
ThunderJet by Toftejorg for automatic cleaning power

## Some of the world's best brews depend on Toftejorg.



The dual rotation of the jets builds up interwoven figure "8" patterns for a clean sweep of the surface.

The Toftejorg machines rotate 360° in the horizontal and 360° in the vertical planes.



A growing number of the world's breweries are using Toftejorg automated cleaning equipment and systems. And for good reason. Take advantage of Toftejorg's on-site engineering analysis and proven benefits, including:

- An unmatched selection of machine designs that can be tailored to your exact applications—from brew kegs up to large storage or process vessels.
- Unique design and customized positioning of Toftejorg equipment yields maximum cleaning efficiency with less water and chemical consumption.
- Savings of up to 50% in water, chemicals and time are not uncommon with Toftejorg.

**Call or write Toftejorg or your local representative for a free cost/benefit analysis of your tank cleaning options**



#### North America

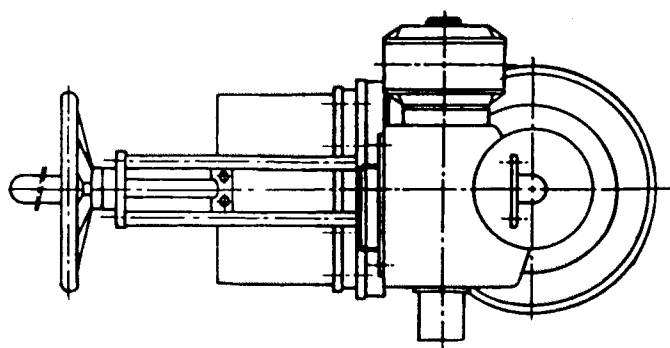
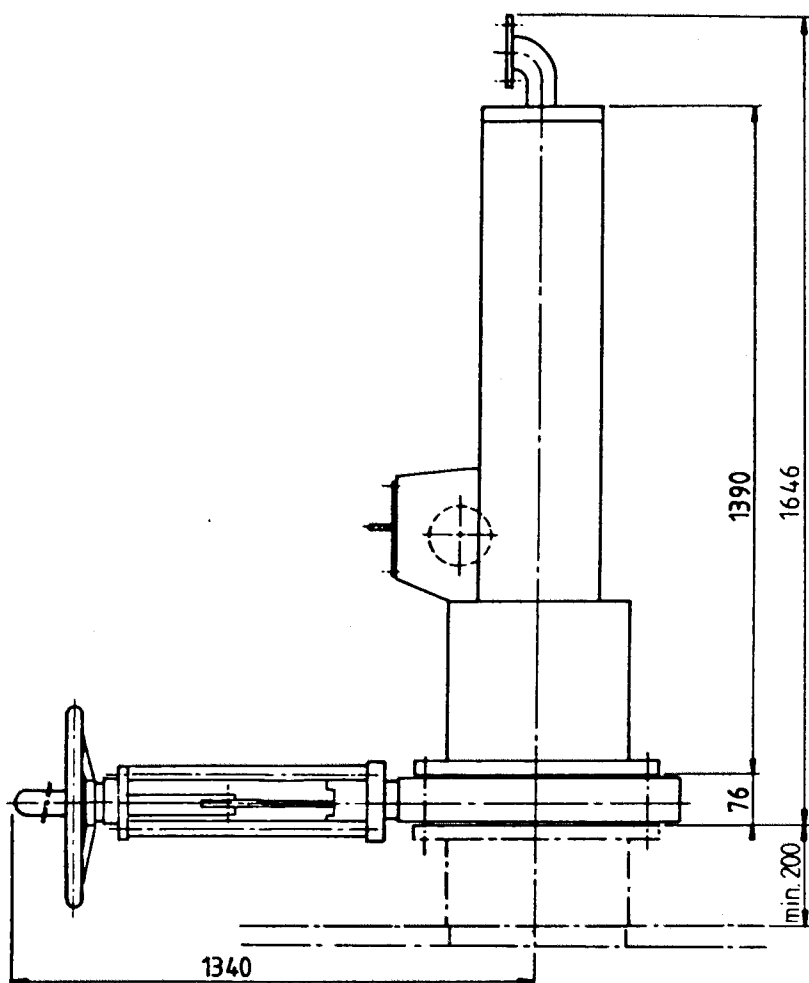
Toftejorg, Inc.  
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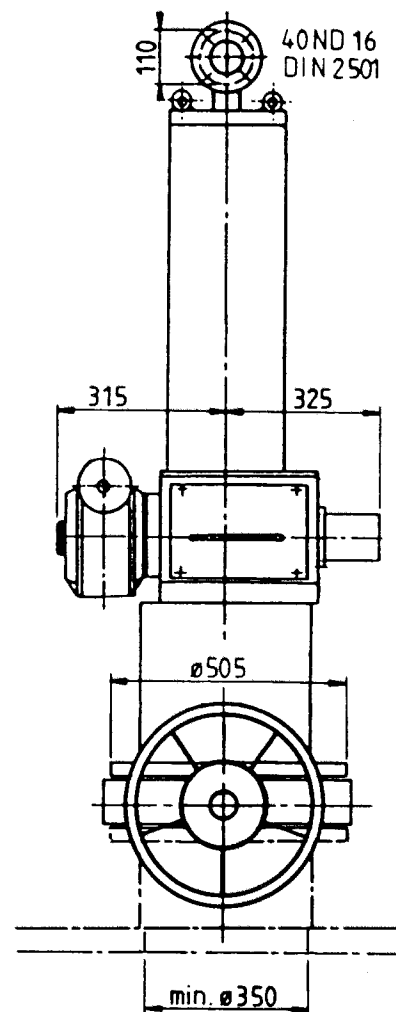
#### United Kingdom

Toftejorg, Ltd.  
Sanderum House, Oakley Road  
Chinnor Oxon OX9 4TW  
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Phone: + 44 844 54171  
Fax: + 44 844 54144

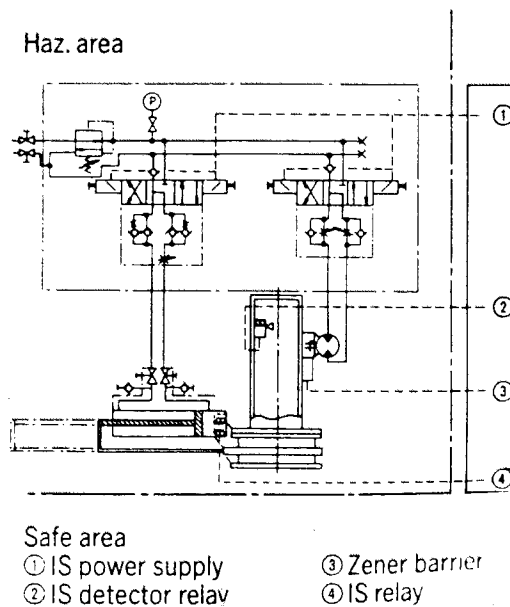


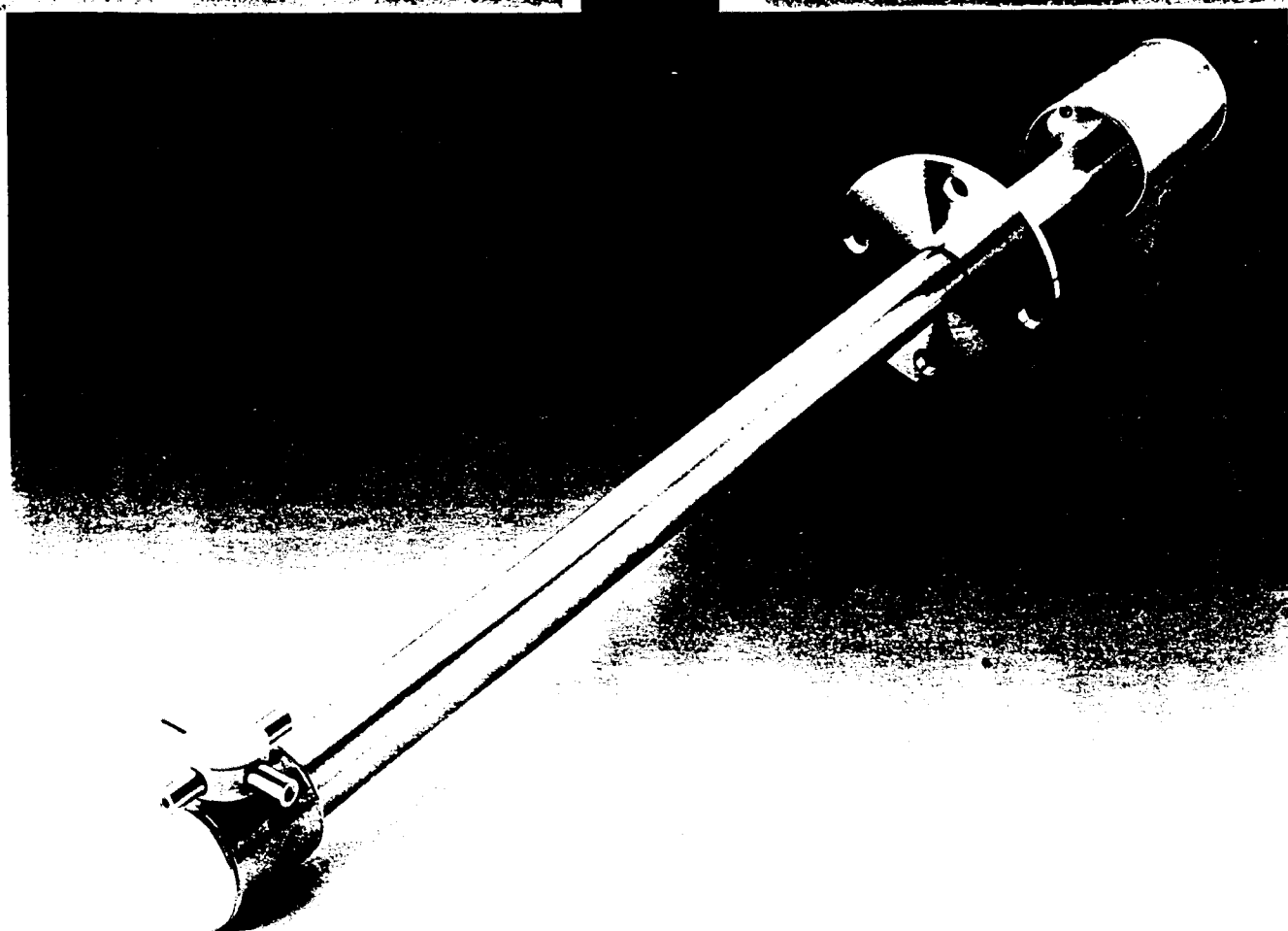
# **TECHNICAL DATA**

Material	Stainless steel AISI 316L
Max. extended length	6.3 m (20.7 ft.)
Height above connection flange	1,700 mm (67 inch)
Working pressure	Max. 12 bar (175 psi)
Max. pressure	16 bar (232 psi)
Temperature	95°C (203°F)
Mounting	Flange
Min. deck opening	350 mm (13.78 inch)
Min internal diameter of extension pipe	1 1/2"
Options	Manual, hydraulic, electric and pneumatic local or



## **Hydraulic Control System**





# TOFTEJORG

## Tank Cleaning Equipment Type TZ-89

TOFTEJORG tank cleaning machines have been developed for automatic cleaning of tanks and process vessels. They are used all over the world in a wide variety of industries, optimizing cleaning efficiency, consumption of water and energy as well as safety for personnel and environment.

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Telex: 362102 tofte hou

■ **TOFTEJORG GmbH**

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2082 Tornesch  
Germany

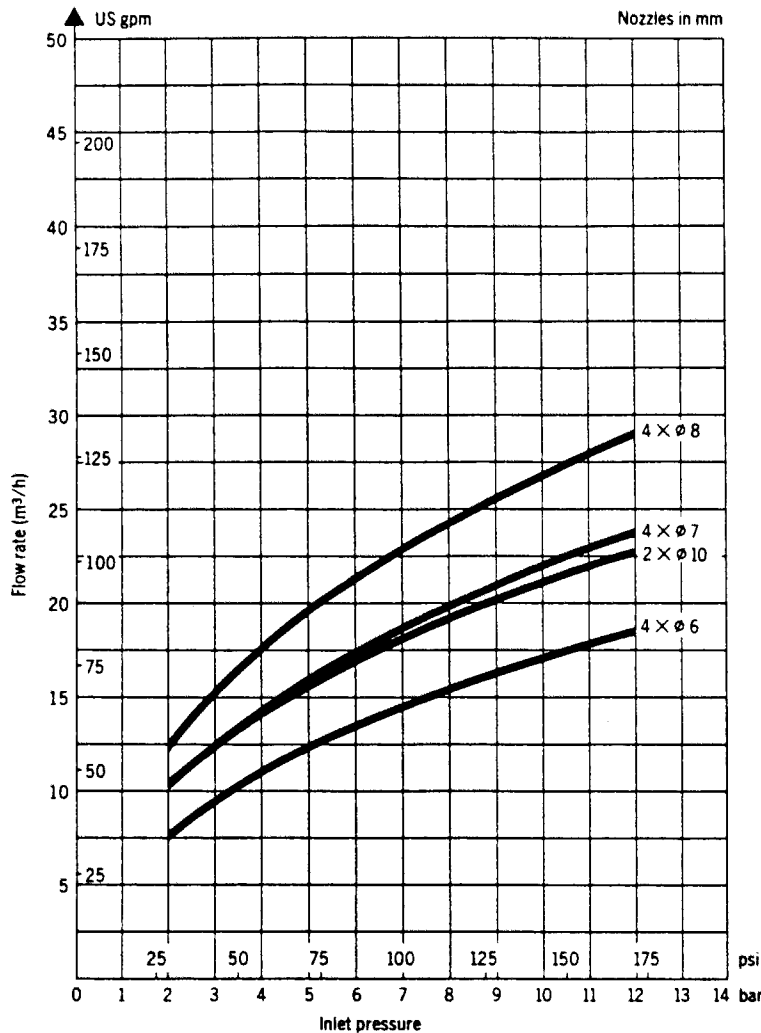
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■ **TOFTEJORG, Ltd.**

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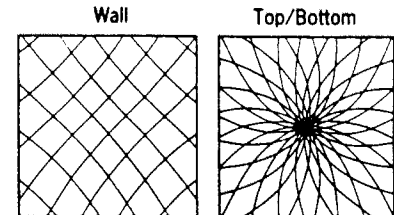
Phone: +44 844 54171  
Telefax: +44 844 54144  
Telex: 837789 ajb g

## Capacity Diagram

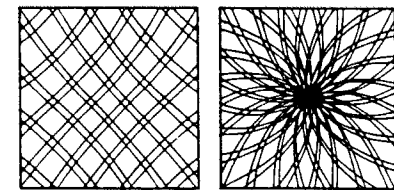


## Cleaning Pattern

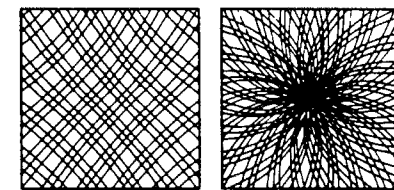
During the first cleaning cycle, a coarse pattern is laid out on the tank surface. During the following cycles, the pattern gradually becomes more dense until a full pattern is reached after 8 cycles.



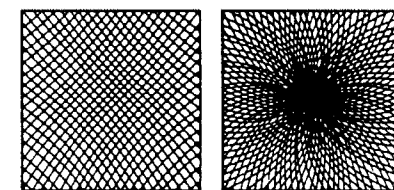
1st cycle. Light Wash.



2nd cycle. Moderate Wash.



3rd cycle. Heavy Wash.



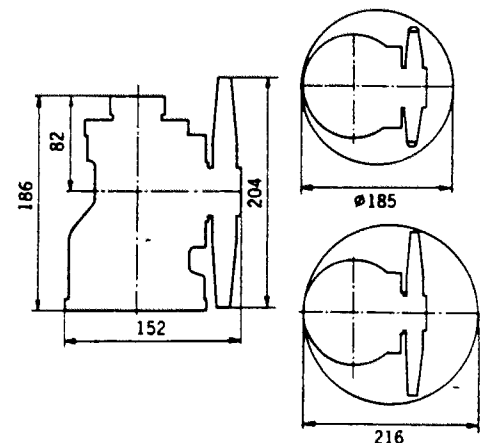
4th cycle. Heaviest Wash.

## TZ-67

Material	Stainless Steel AISI 316 L, PTFE, PVDF, Carbon
Weight	6,5 kgs (14,3 lb) portable model
Lubricant	Selflubricating with the cleaning fluid
Working pressure	2-12 bar (30-174 psi)
Recommended inlet pressure	3-8 bar (44-116 psi)
Maximum working temperature	95°C (203°F)
Throw length	Between 7 and 24 meters (23 and 79 ft.) depending on machine configuration and pressure
Effective throw length *)	Between 4 and 13 meters (13 and 43 ft.) depending on machine configuration and pressure
Cycle time	Between 3 and 10 minutes depending on machine configuration and pressure
Installation	Portable
Standard thread	1½ inch BSP or NPT for portable installation
Minimum required passage	185 mm (7,28 inch)

\*) Impact in center of jet 250 mm (9,84 inch) water column

## Principal dimensions in mm



# 42% less waste water with the TOFTEJORG Sani-Midget tank cleaning device.



*The TOFTEJORG Sani-Midget saves  
water and chemicals compared  
with a conventional sprayball.*

- Independent test proves that the TOFTEJORG Sani-Midget tank cleaning device uses 42% less water than a conventional sprayball, with no loss in cleaning performance.
- The Sani-Midget is also self-cleaning, making it applicable in the food and beverage industry as well as all other industries with high sanitary requirements.
- Other Sani-Midget advantages include shorter cleaning time and reduced usage of cleaning chemicals.
- The Sani-Midget is available in both threaded and clip-on versions for easy replacement of a sprayball. It may also be welded to the inlet pipe.
- TOFTEJORG offers a complete line of tank cleaning equipment, designed to match any type and size of vessel.

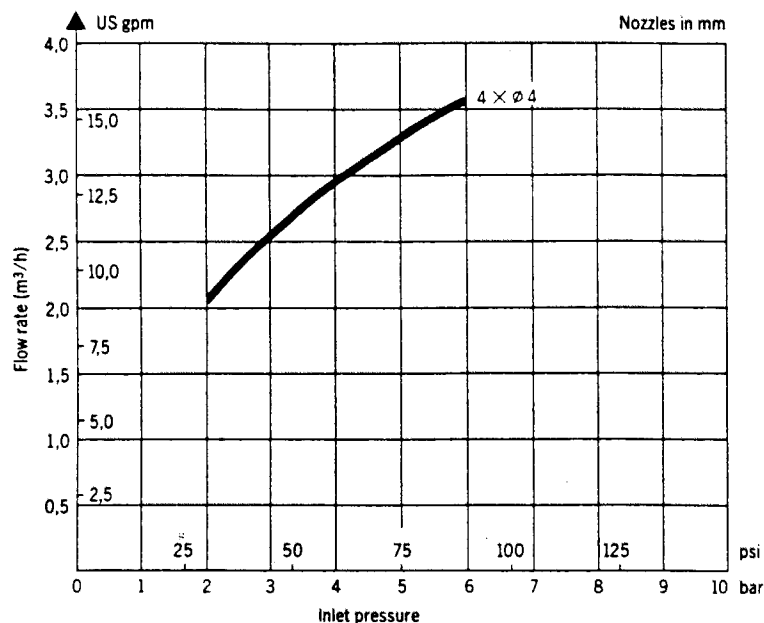
**Call or write TOFTEJORG or your local representative for a free copy of the Sani-Midget test results, or a cost/benefit analysis for your tank cleaning options.**



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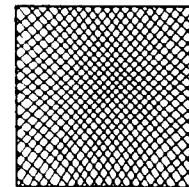
**Toftejorg A/S**  
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2635 Ishøj, Denmark  
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Fax: +45 42 52 75 52

## Capacity Diagram

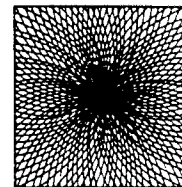


## Cleaning Pattern

A complete cleaning pattern in a square tank looks as illustrated below.

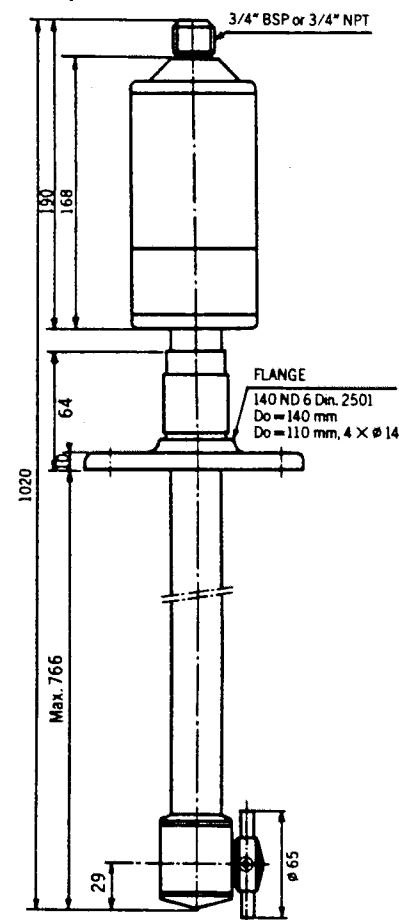


Side pattern.



Top and bottom pattern.

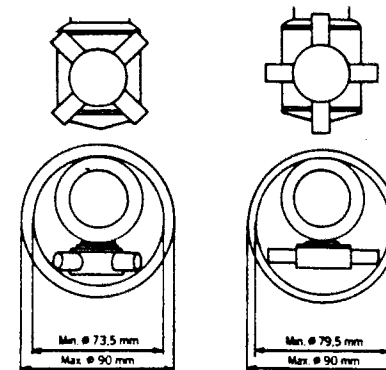
## Principal dimensions in mm



## TZ-89

Material	Stainless Steel AISI 316 L, PTFE, PVDF, Viton
Weight	7 kgs (15,4 lb)
Lubricant	Selflubricating with the cleaning fluid
Working pressure	2-7 bar (30-100 psi)
Recommended inlet pressure	3-6 bar (43-87 psi)
Maximum working temperature	90°C (194°F)
Throw length	Between 4 and 7 meters (13 and 23 ft.) depending on machine configuration and pressure
Effective throw length *)	Between 2½ and 4 meters (8 and 13 ft.) depending on machine configuration and pressure
Cycle time	Between 8 and 16 minutes depending on machine configuration and pressure
Installation	TZ-89 is designed for vertical installation, but can operate horizontally or in any wanted angle position
Standard thread	¾ inch BSP or NPT for fixed or portable installation
Minimum required passage	Recommended tank hole 80 mm (3,15 inch)
Flange	140 ND6, DIN 2501 of 2" ANSI B 16,5

\*) Impact in center of jet 250 mm (9,84 inch) water column





# TOFTEJORG

## Sani Midget and Sani Magnum

The Midgets and Magnums are specially designed sanitary rotating tank cleaning units, optimizing cleaning efficiency, consumption of water, energy and detergents.

### New Complete Sanitary Design:

- Fully welded assembly
- No thread connections (except for thread-models)
- No sharp internal corners
- Ball bearing and all gaps are flushed through for maximum biostability
- New larger cleaner head for complete self cleaning - also of downpipe (except 180° down version)

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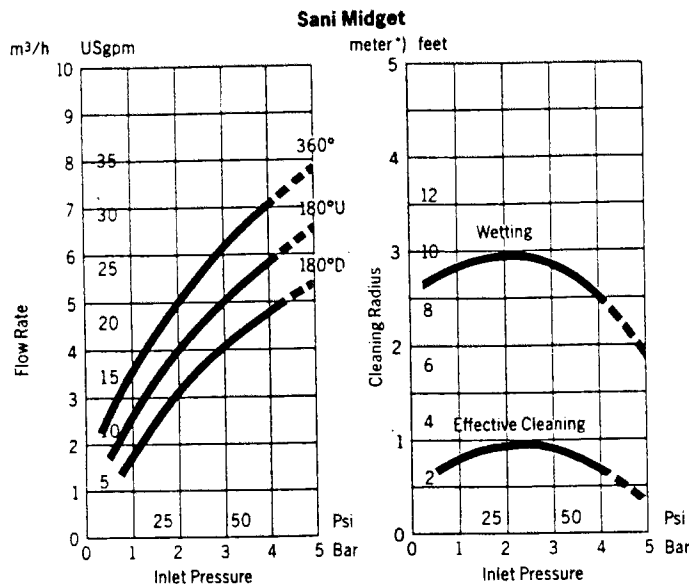
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#### ■ TOFTEJORG, Ltd.

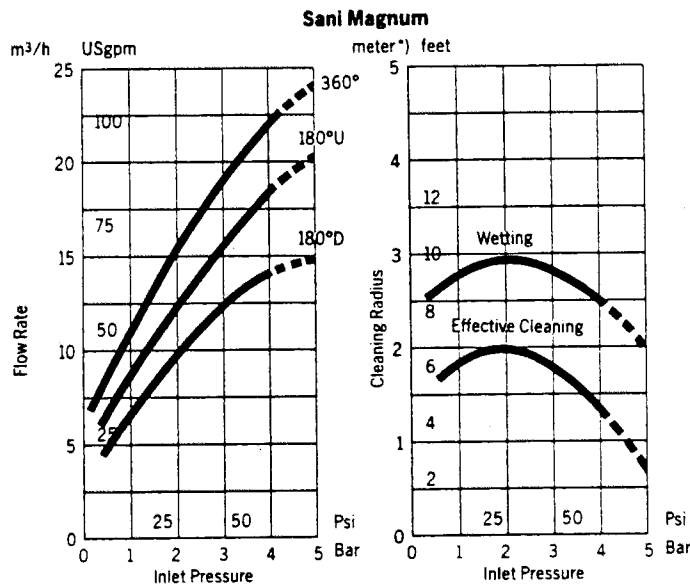
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Telefax: +44 844 54144  
Telex: 837789 ajb g

## Capacity Diagram



For Clip-on models flowrate is approx. 10% higher

\*) Effective throw length varies depending on substance to be removed and cleaning procedure and agent.

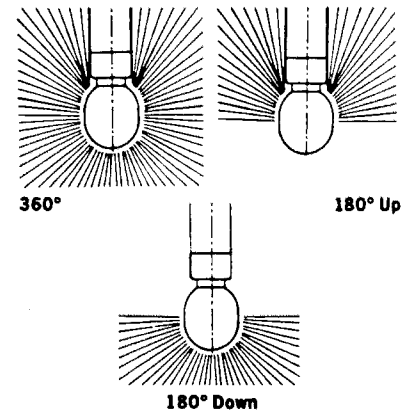


For Clip-on models flowrate is approx. 10% higher

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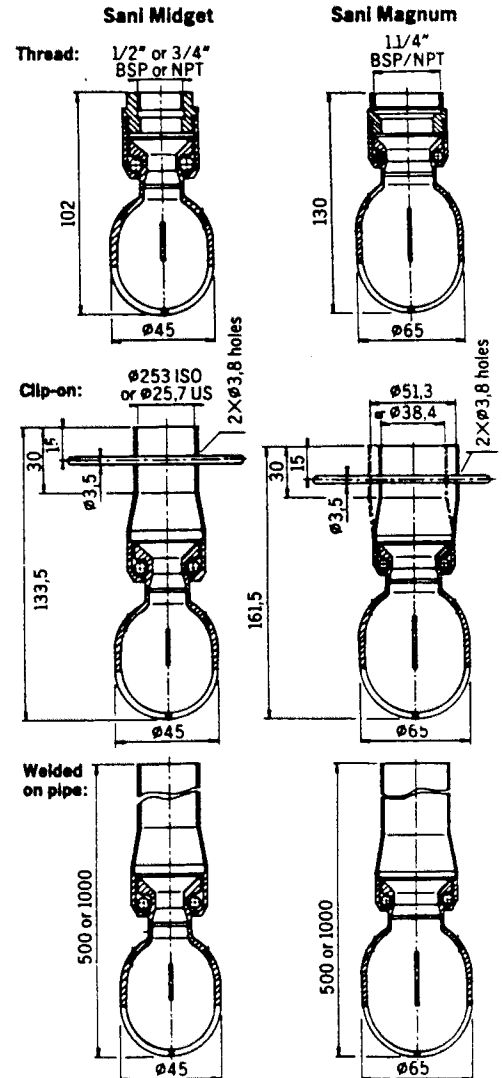
	<b>Sani Midget</b>	<b>Sani Magnum</b>
<b>Material</b>	Stainless Steel: Housing: SAF 2205 (≈UNS 31803) Balls: Hardened SS: Others: AISI 316 L	Stainless Steel: Housing: SAF 2205 (≈UNS 31803) Balls: Hardened SS: Others: AISI 316 L
<b>Weight</b>	Thread and Clip-on: 0.30 kgs (0.66 lb) On pipe: 0.55/0.90 kgs 1.2 lb/2.0 lb	Thread and Clip-on: 0.67 kgs (1.5 lb) On pipe: 0.97/1.52 kgs 2.1 lb/3.41 lb
<b>Lubricant</b>	Selflubricating with the cleaning fluid	Selflubricating with the cleaning fluid
<b>Working pressure</b>	0.5-4 bar (7.58 psi)	0.5-4 bar (7.58 psi)
<b>Recommended inlet pressure</b>	2 bar (30 psi)	2 bar (30 psi)
<b>Max. temperature</b>	140°C (284°F)	140°C (284°F)

## Spray Angles



Can also be installed in horizontal position or other angles.

## Principal dimensions in mm:





**TOFTEJORG, Inc.**

**QUESTIONNAIRE FOR TANK CLEANING AND EQUIPMENT RECOMMENDATION**

Date Received: _____	TCQ Number: _____	Last Update: _____
Company : _____	Comp. Profile No. : _____	
Address : _____	Contact Profile No. : _____	
_____	Contact: _____	
_____	Position: _____	
City : _____	Telephone: _____	
State/Province : _____	Telefax: _____	
Zip Code : _____	Postal Code: _____	Telex: _____
Country : _____	Market Segment: _____	
Region : _____	Project No.: _____	

**SALES AND TECHNICAL RESPONSIBILITY**

Dealer/Representative: _____	Comp. Profile No.: _____
Location of the Dealer: _____	
Dealer Salesman: _____	Cont. Profile No.: _____
Toftejorg Salesman: _____	Salesman No.: _____

**EQUIPMENT TO BE CLEANED**

- A.) Customer's name of the tank/vessel to be cleaned: \_\_\_\_\_
- B.) Dimensions and function of the tank or vessel in question (Attach drawing if possible): \_\_\_\_\_
- C.) Surfaces to be cleaned. Describe the composition of the tank/vessel surfaces: \_\_\_\_\_
- D.) New construction or existing equipment: \_\_\_\_\_
- E.) Quantity of tanks/vessels of this type to be considered: \_\_\_\_\_
- F.) Do conditions require sanitary equipment: \_\_\_\_\_
- G.) What tank/vessel openings are available for the installation of Toftejorg equipment: \_\_\_\_\_
- H.) Is 100% cleanliness of the subject tank/vessel required (If no, what is acceptable): \_\_\_\_\_
- I.) What percentage of shielded areas (areas that cannot be impinged upon by direct contact of the jet length) are acceptable: \_\_\_\_\_



**TOFTEJORG, Inc.**

**PRESENT METHOD OF CLEANING**

**PRESENT PRACTICE:**

None: \_\_\_\_\_ Manual: \_\_\_\_\_ Flotation: \_\_\_\_\_ Competitive Manufacturer: \_\_\_\_\_

Comments: \_\_\_\_\_

**FREQUENCY OF CLEANING:** \_\_\_\_\_

**PRESENT CLEANING TIME:** \_\_\_\_\_

**REASON FOR CLEANING**

achieve sterility : \_\_\_\_\_ Prevent cross contamination : \_\_\_\_\_

prevent heat transfer : \_\_\_\_\_ Sludge/sediment removal : \_\_\_\_\_

Preparation for maintenance or inspection: \_\_\_\_\_

Comments: \_\_\_\_\_

**FIXED OR PORTABLE APPLICATION:** \_\_\_\_\_

**DESIRED CLEANING TIME:** \_\_\_\_\_

**TYPE OF SOILAGE**

Hydrocarbon \_\_\_\_\_ Volatile/explosive \_\_\_\_\_ Sticky/tenacious \_\_\_\_\_

Chemical \_\_\_\_\_ Hard/crusted \_\_\_\_\_ Organic \_\_\_\_\_

Toxic \_\_\_\_\_ Soft/soluble \_\_\_\_\_ Inorganic \_\_\_\_\_

Amount of the material to be removed from the subject tank/vessel. \_\_\_\_\_

What is the material soluble in. \_\_\_\_\_

**BUDGET CONSIDERATIONS**

What are the cost expectations/limitations: \_\_\_\_\_



**TOFTEJORG, Inc.**

**CURRENT OR AVAILABLE OPERATING PARAMETERS**

**A.) SUPPLY PRESSURE**

A1.) At Pump

A2.) At Current Cleaning Device

**C.) FLOW RATE**

C1.) At Supply Pump

C2.) At Current Cleaning Device

C3.) At Suction Side of Tank

**B.) CONVEYANT**

**D.) CONVEYANT TEMPERATURE:**

**E.) TYPE OF VALVE**

**F.) STEAM INJECTION:**

**ADDITIONAL INFORMATION**

Is a complete CIP system required:

Comments:

**FOR DEMONSTRATION PURPOSES ONLY**

Should the demonstration of our products meet your requirements, will a purchase be made within 30 days of test termination? If no, give explanation:



**CUSTOMER'S EXPECTATIONS**

Describe your requirements of our equipment and your primary points of interest. What are your desired results?

**TECHNICAL RECOMMENDATION OF EQUIPMENT AND COMMENTS**

**INFORMATION OBTAINED BY:**

**EVALUATION BY:**



**TOFTEJORG, Inc.**

February 14, 1992 - Friday

United Engineers & Constructors, Inc.  
P. O. Box 5888  
Denver, Colorado 80217  
USA  
Attention: Mr. Myron Schultz

Reference: **"Toftejorg Tank Cleaning Machines"**

Dear Sir,

Thank you for responding to our advertisement in Chemical Processing magazine. We have enclosed a literature packet which details some of our product line. Within the packet is a "Tank Cleaning Questionnaire" which presents various questions that enable us to best prescribe our most appropriate device for your needs. Should you have a requirement, please complete the form and send to us in the most convenient manner. Our engineering section will evaluate the application and forward to sales for an immediate commercial proposal to your attention. Toftejorg offers the following services relative to our products:

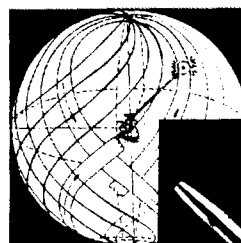
Installation Drawings  
On-Site Analysis of Cleaning Application  
Cleaning Procedures  
Engineering Assistance  
Service Training of Personnel  
Cost Benefit Analysis

Again, thank you for your interest in our products. If we can be of any assistance, please do not hesitate to contact us.

Best regards,

Toftejorg, Inc.

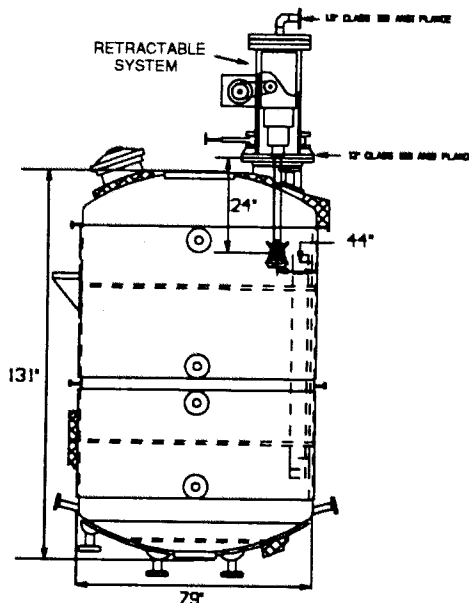
*Troy R. Humphries*  
Troy R. Humphries  
Executive Vice President



The Toftejorg machines rotate 360° in the horizontal and 360° in the vertical planes.



The dual rotation of the jets builds up interwoven figure "8" patterns for a clean sweep of the surface.



CHEMICAL REACTOR

2614 East Beltway Eight, Pasadena, Texas 77503 U.S.A.  
Phone: (713) 487-7851, Telex: 362102 TOFTE HOU, Fax: (713) 487-7937



**TOFTEJORG, Inc.**

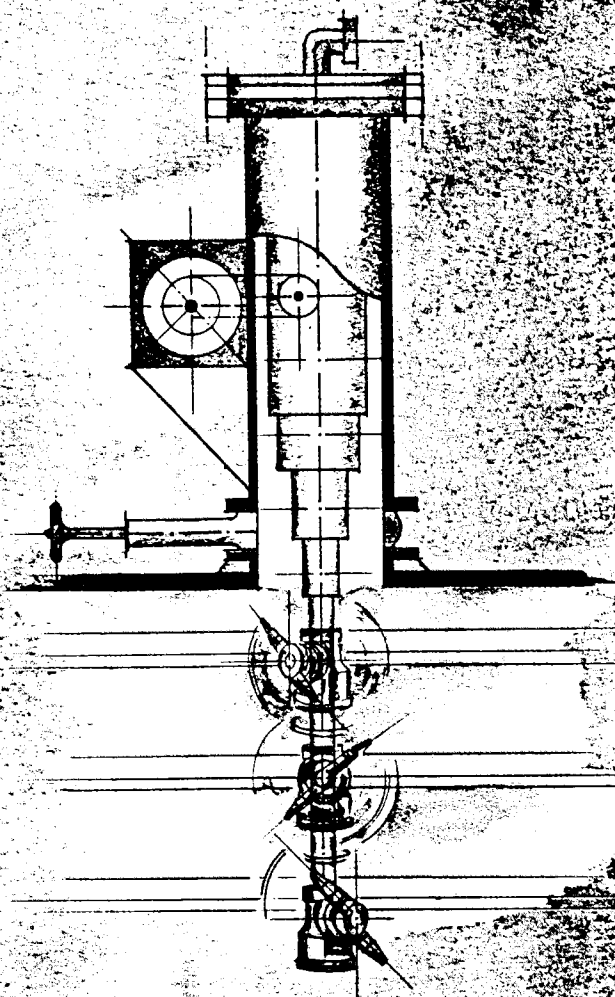
**TOFTEJORG COMPANIES**

**Presents**

**The  
RETRACTASYSTEM**

**"Automated Tank Cleaning Equipment"**

2614 East Beltway Eight, Pasadena, Texas 77503 U.S.A.  
Phone: (713) 487-7851, Telex: 362102 TOFTE HOU, Fax: (713) 487-7937.



# TOFTEJORG Retractable System

## Semi or Fully Automatic Retractable Tank Cleaning System.

Independent cleaning at various levels in a closed atmosphere and under all weather conditions.

- Tank cleaning can be carried out by the operator on duty from a remote location.
- Programmable to uniform cleaning procedures for all applications.
- Ease of maintenance, due to accessibility.
- Portable equipment can be reduced or eliminated due to flexibility of the system.

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■ **TOFTEJORG, Ltd.**  
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# RETRACTASYSTEM

PM0145  
010990

Page 1

TOFTEJORG has developed a retractable and withdrawable tank cleaning system to replace systems with fixed extension pipes and/or swingarm systems, considering the facts that:

- fixed tank cleaning machines are unfit to be submerged in certain cargoes,
- the use of portable tank cleaning machines requires manpower,
- the environment and the risk of explosion is not properly considered with the portable tank cleaning machines,
- the existing retractable swingarm systems are difficult to clean and do not ensure that the tank cleaning machines are fully withdrawn from the tank,
- no automatic retractable and withdrawable tank cleaning machines is on the market, and
- IMO requires prewash with closed tanks.

The following design criteria have been considered in connection with the development of the TOFTEJORG retractable tank cleaning machine system:

## General Design Criteria

- Fully retractable and withdrawable tank cleaning machine
- Easy to handle
- Easy to repair
- Prepared for automatic lowering and hoisting
- Few spare parts
- Prepared for remote control
- Adjustable
- Compact unit for mounting on a deck flange
- Self draining and self cleaning
- Seawater and chemical resistant towards ordinary used chemicals for cleaning
- Vibration resistant
- Able to function under an inclination of 20° - 0° - 20°
- Secured against falling down
- Simple and strong
- Disassembly with cargo still in tank
- Sealing off from the tank
- With build-in drive unit and extension indicator



## Tank Types and Sizes

The system is suited for the following tank types and sizes:

Marine tanks	:	Tanks from 100 - 30.000 m <sup>3</sup>
Marine bulks	:	Cargo holds from 30.000 m <sup>3</sup>
Industry	:	Tanks from 25 - 5.000 m <sup>3</sup>

## Technical Data

Min. internal diameter of retractable extension pipe	1 1/2"
Max. internal diameter of retractable extension pipe	2"

Max. pressure	:	PN 16
Working pressure	:	Max. 10 bar
Max. height above deck	:	1700 mm
Material	:	Stainless Steel AISI 316
Machine mounting	:	Flange

The height above deck must be of max. 1,700 mm for an extension length of approx. 9.5 m. Shorter extension length can result in lower height above deck. The height 1,700 mm above deck is chosen as most hatch coamings on OBO carriers have a height above 1,700 mm.

The diameter of the pipe above deck is corresponding to a deck opening of approx. 310 mm.

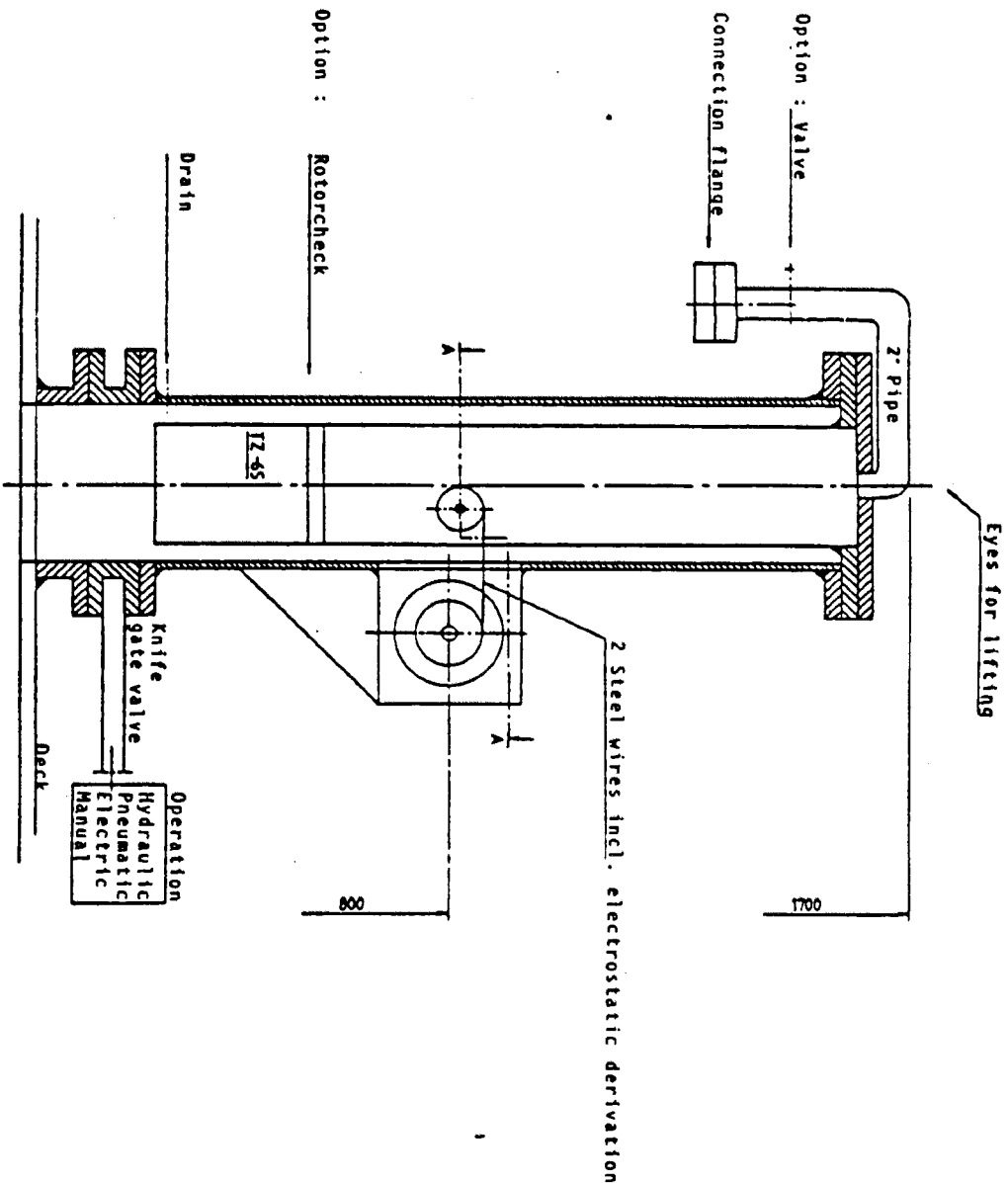
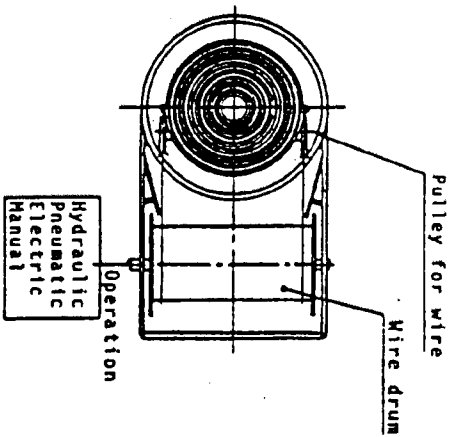
## Life

Spare parts	:	15 years
Wear parts	:	2,000 working hours

## Class

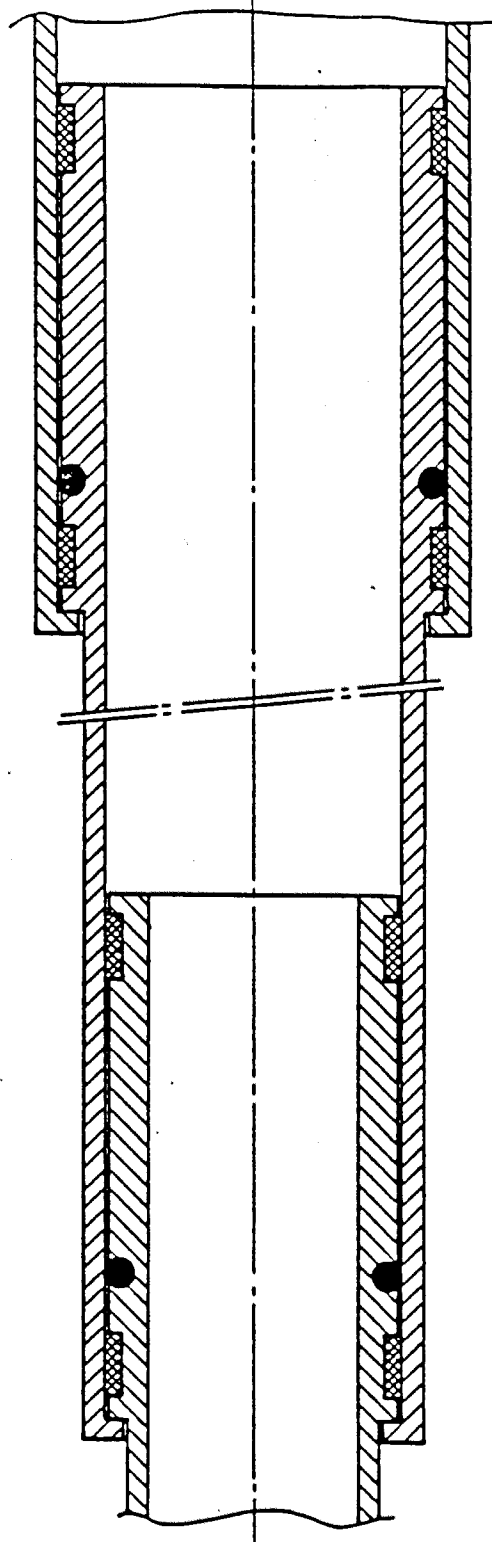
IMO/DNV/ABS

Can be delivered in conformity with requirements of other classification societies.



PAT. PENDING

Description: <b>Retractable extension pipe</b>		Scale:
Material: TOFTEJORG AS Tofte & Jørgensen Toftevej 19 890502 Toftevej 19 890502		Drawing: 80 Date: 890502
Drawing no.: <b>890501</b>		Version no.: 891



This drawing is the property of TOFTEJORG and must not be copied, handed or otherwise dispatched to any third party without our written permission.

Description: **RETRACTASYSTEM**  
Joints between tubes.

Scale: ~

Material:

Drawn:  
JEP/bo

Date:  
890609

Checked:

Appr.:



**TOFTEJORG A/S**  
Tofte & Jørgensen

Baldersvej 79 Phone: +45 2 52 85 66  
Box 1149 Tele: 31288 tofte dk  
DK-2635 Ishøj Telefax: +45 2 52 75 52

Drwg.no:

890601

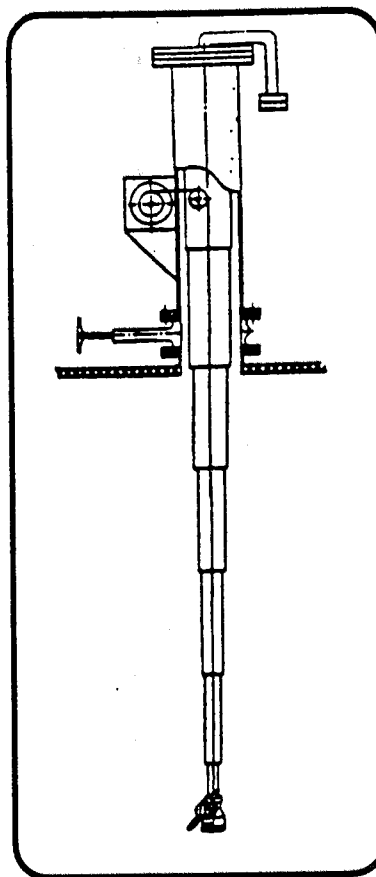
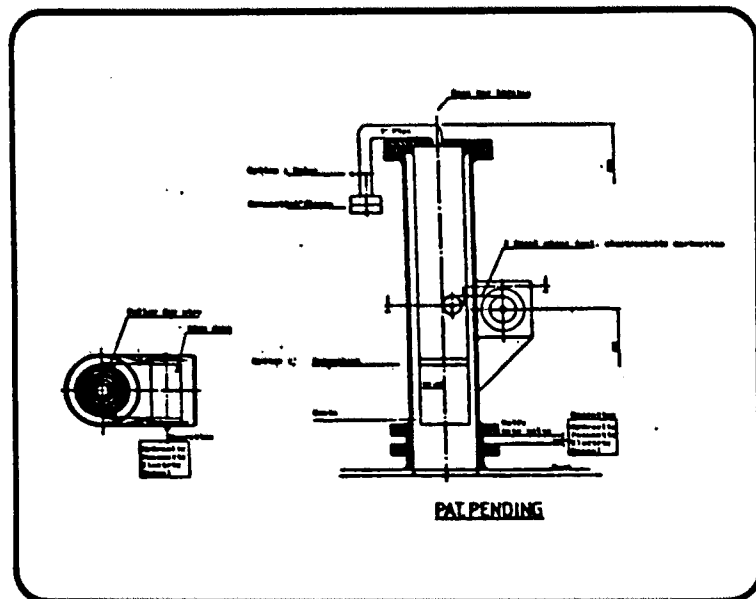
Version no:

891

# RETRACTASYSTEM™



PM0149  
011190  
TRH



The Toftejorg "Retractablesystem" is a revolutionary design which employs various models of Toftejorg Tank Cleaning Machines and enhances their performance by allowing the extension and retraction of the cleaning head. The following benefits are accomplished:

- The Tank Cleaning Machine Is Not Subjected To Undesirable Conditions
- Maintenance Can Be Performed Outside The Host Tank, Vessel, Reactor, Etc.
- The Seal Upon The Host Tank, Vessel, Reactor, Etc. is Uncompromised
- Personnel Is Not Subjected To Potentially Dangerous Atmospheres
- Environmental Conditions Are Less Likely To Be Subjected To Hazardous Material

***Call or write for additional information and technical analysis of your application.***

**Toftejorg, Inc.**  
2614 East Beltway Eight  
Pasadena, Texas 77503  
U.S.A.  
Phone: (713) 487-7851  
Fax: (713) 487-7937

**Toftejorg A/S**  
Baldershoj 19  
Box 1149  
DK-2635 Ishoj Denmark  
Phone: 45 42 52 86 66  
Fax: 45 42 52 75 52

**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

**RECORD OF TELEPHONE CONVERSATION**

DATE 2-10-92

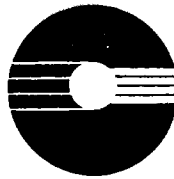
TIME 1:30 PM

PAGE 1 OF 1

FROM: MYRON SCHULTZ TO: PHIL JOACHIM  
COMPANY: UE & C COMPANY: CHEMDET, INC.  
PHONE: 843-2454 PHONE: 1-800-645-1510  
REFERENCE/PROJECT NO.: 6299.001 NREL  
SUBJECT: FERMENTING / DIGESTER TANKS  
TANK C.I.P. SYSTEM

TOPICS OF CONVERSATION:

- CHEMDET MAKES A TANK CLEANING TOOL THAT WILL CLEAN TANKS UP TO 120'-0" DIA. IT CAN BE INSERTED FROM THE TOP WHEN CLEANING IS REQ'D. OR BUILT-IN AND LEFT IN PLACE IN EACH TANK TO BE TURNED ON WHEN REQUIRED.  
THIS WOULD BE THEIR MODEL FURY #600, WITH (3) STD. 12 MM NOZZLES.
- PHIL WILL SEND DESCRIPTIVE INFO ON THESE NOZZLES.
- THEY DO NOT NORMALLY GET INVOLVED IN THE DESIGN OF THE C.I.P. SYSTEM OTHER THAN TO FURNISH THE CLEANING HEADS, BUT AFTER WE GET A SPEC. WRITTEN UP, THEY MAY BE ABLE TO HELP US WITH SYSTEM DESIGN.
- PHIL DID NOT THINK A LINED TANK WOULD BE A PROBLEM WITH AN IMPINGEMENT TYPE CLEANER. HE SAID THAT MOST OF THE TANK CAN APPLICATIONS THEY FURNISH HEADS FOR ARE LINED SYSTEMS.



**Chemdet**

*Advanced Ideas In Cleaning*

February 10, 1992

Mr. Myron Schultz  
United Engineers & Constructors, Inc.  
P.O. Box 5888  
Denver, CO 80217

Dear Mr. Schultz:

Thank you for requesting information about Chemdet tank and vessel washers. Your interest in our products is greatly appreciated.

The enclosed literature describes the majority of our many models of washers, ranging from the mighty Fury Model 600, with a high-impingement cleaning radius of up to 66 feet, to the little Turbodisc 75/360, designed specifically to easily fit through the standard two-inch bunghole of a barrel or 55-gallon drum. For permanent clean-in-place (CIP) installations requiring the highest sanitary standards, we offer the S-Turbodisc rotating disc washers. These units comply with 3-A, USDA and FDA specifications. Other specialty tank washers include two Fury models designed specifically to direct their powerful jets upwards or downwards only in a 180 degree spray pattern. They are ideal for concentrated washing in one area of a tank or for open-top vessel cleaning.

We maintain a well-stocked equipment and parts inventory and our service department is fully qualified to recondition or offer technical assistance for the equipment we sell.

Based on our conversation, the Fury 600 Mark IV with 12mm nozzles is the tank washer model best suited for your current project. Please let me know if you have any questions or if additional information would be helpful. We would welcome an opportunity to work with you.

Sincerely,

CHEMDET, INC.

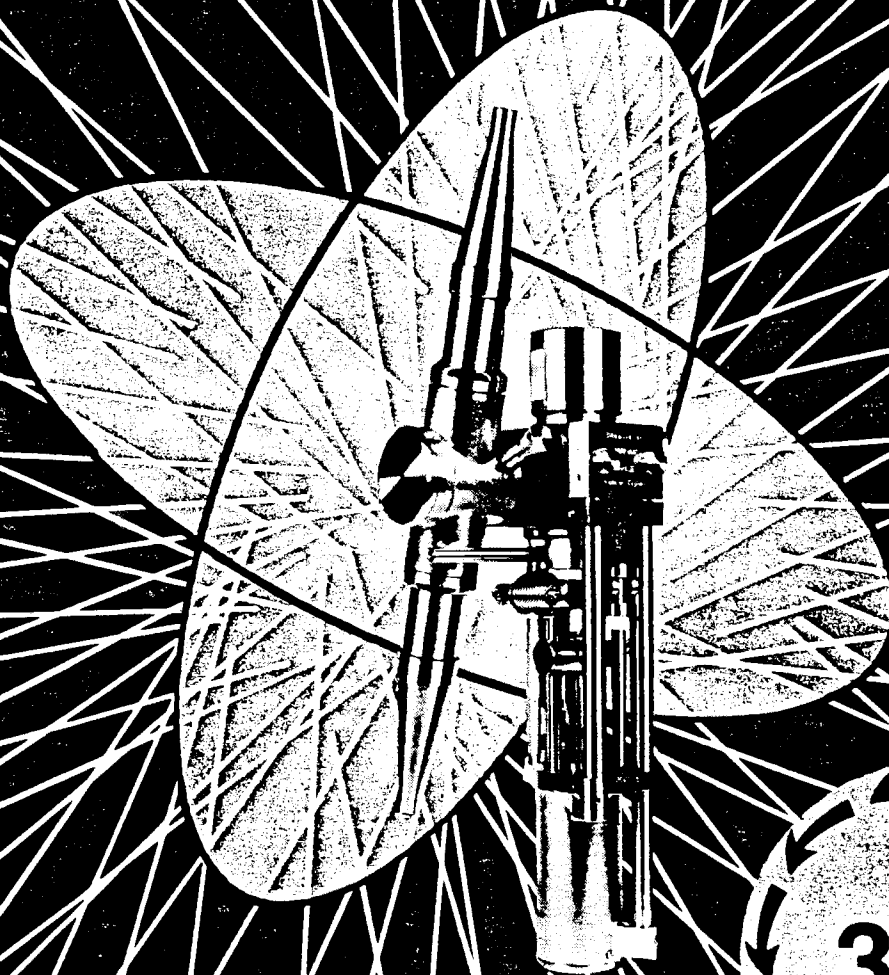
Phillip M. Joachim  
President

PMJ:lrs  
Enclosures

CHEMDET

CHEMDET

# CHEMDET, Inc.



**360°**

## TANK WASHERS

for 100% Vessel Cleaning

### TOTAL TANK CLEANING

**A Complete Range  
for Large or Small  
Open or Closed Vessels**



## TANKWASHERS

The **FURY** line of Tankwashers is the best solution to your most difficult tank cleaning problems. **FURYs** are exceptionally powerful and efficient, yet simple and reliable. Built to clean the most difficult chemical residues from the interiors of tank trucks, tank cars, reactor kettles, process and storage vessels, the **FURY's** unique design also makes it the ideal choice for cleaning beer, wine, soft drink and other food grade tanks.

Constructed of stainless steel, **FURY** Tankwashers will withstand today's aggressive cleaning solutions, yet **FURYs** use absolutely **NO OIL OR GREASE**... the cleaning fluid is the only lubrication necessary.

The **FURY** is self-powered by the cleaning fluid passing through it. The jet nozzles reciprocate vertically, with an indexed horizontal turning for complete 360° coverage of the vessel interior. Unlike most other tank washers, the **FURY** is not dependent on high internal flow rates and pressures. The **FURY's** speed of operation and cycle time can be fine tuned for maximum cleaning efficiency in minutes, regardless of the flow rate or pressure.

The **FURY** was designed with low maintenance costs in mind. Its steady piston drive eliminates the high speed gears, excessive wear and expensive parts replacement associated with turbine machines. **FURY** tankwashers are simple, reliable and inexpensive to maintain.

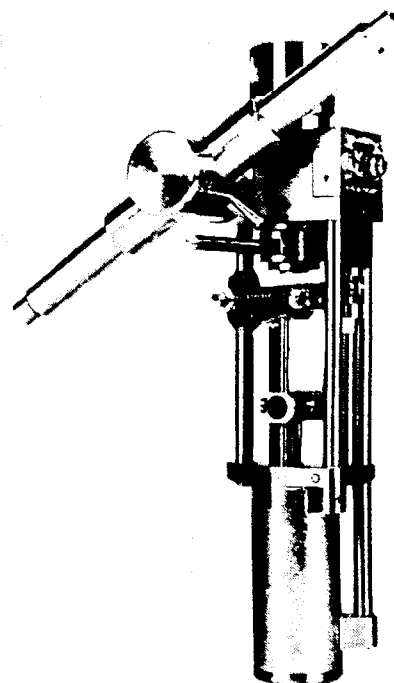
Because **FURYs** are lightweight, they can easily be moved from tank to tank or they can be mounted permanently for C.I.P. applications.

### KEY FEATURES of the FURY Tankwasher

- Powerful and Efficient
- Simple and Reliable
- Unique Design
- No Oil or Grease Lubrication
- Lightweight
- Low Maintenance Cost
- Self-powered
- Stainless Steel Construction



**Model 400  
Mark IV  
For Pressures  
40 to 180 psi**



### SPECIFICATIONS:

Cleaning radius .....	16 to 27 ft.
Flowrate .....	5 to 45 gpm
Weight .....	4 1/2 lb.
Nozzles .....	1/8", 3/16", 1/4", 5/16"
Inlet .....	1"
Overall length .....	10 3/8"
Operating temperature .....	248°F. max.
Min. opening req'd .....	5" dia.

### MATERIALS:

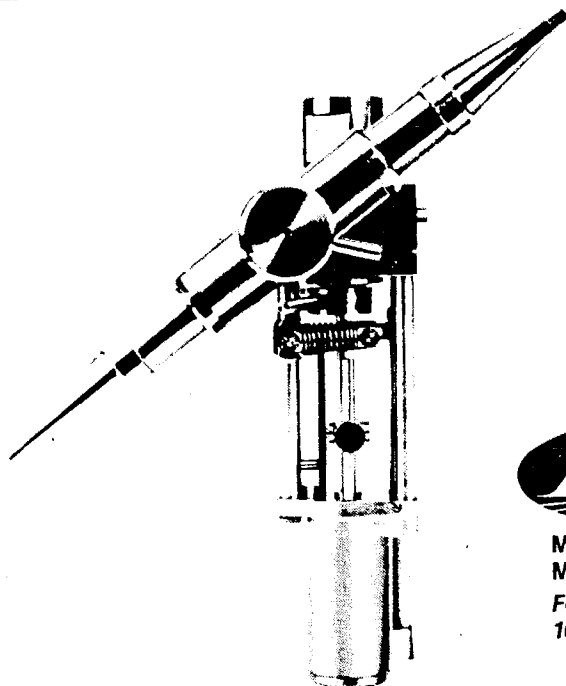
Stainless Steel .....	Type 304 & 440C
Teflon .....	25% carbon filled
O-Rings .....	Nitrile

### PERFORMANCE DATA

Nozzle Size INCH	Pressure PSI	Flowrate GPM	Cleaning Radius FEET
2 x 1/8"	40	5.0	16
	60	5.7	18
	80	6.5	19
	100	7.3	19
	120	8.0	18
	140	8.6	17
2 x 3/16"	40	10.6	20
	60	13.0	22
	80	15.0	24
	100	16.8	24
	120	18.4	22
	140	19.9	20
2 x 1/4"	40	21.2	23
	60	26.0	25
	80	30.0	26
	100	33.6	26
	120	36.8	25
	140	39.7	23
2 x 5/16"	40	22.1	24
	60	27.1	26
	80	31.3	27
	100	35.0	26
	120	38.3	24
	140	41.4	23



**Model 600  
Mark IV**  
For Pressures  
40 to 260 psi



**SPECIFICATIONS:**

Cleaning radius	28 to 66 ft.
Flowrate	34 to 194 gpm
Weight	22 lb.
Nozzles	8, 10 & 12mm
Inlet	1 1/2"
Overall length	15 3/4"
Operating temperature	248°F. max.
Min. opening req'd	10" dia.

**MATERIALS:**

Stainless Steel	Type 304 & 440C
Teflon	25% carbon filled
O-Rings	Nitrile

**PERFORMANCE DATA**

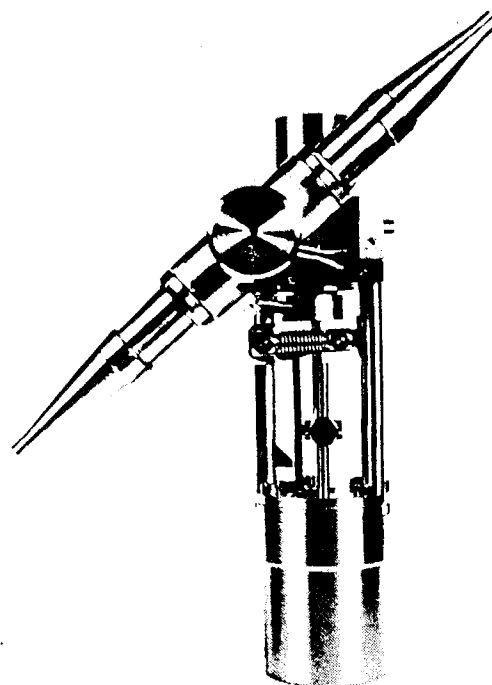
Nozzle Size MM	Pressure PSI	Flowrate GPM	Cleaning Radius FEET
2 x 8 MM <i>35"</i>	40	34	28
	80	48	31
	120	58	33
	160	67	34
	200	75	35
	240	83	35
2 x 10 MM <i>34"</i>	40	53	34
	80	75	40
	120	88	40
	160	102	38
	200	115	36
	240	120	32
2 x 12 MM <i>42"</i>	40	76	41
	80	107	55
	120	131	59
	160	152	63
	200	169	65
	240	186	66

**NOTE:**

Standard length nozzles available in 8 MM & 10 MM.  
Extended range nozzles available in 10 MM & 12 MM.



**Model 610  
Mark IV**  
For Pressures  
10 to 80 psi



**SPECIFICATIONS:**

Cleaning radius	16 to 55 ft.
Flowrate	17 to 107 gpm
Weight	26 lb.
Nozzles	8, 10 & 12mm
Inlet	1 1/2"
Overall length	16"
Operating temperature	248°F. max.
Min. opening req'd	10" dia.

**MATERIALS:**

Stainless Steel	Type 304 & 440C
Teflon	25% carbon filled
O-Rings	Nitrile

**PERFORMANCE DATA**

Nozzle Size MM	Pressure PSI	Flowrate GPM	Cleaning Radius FEET
2 x 8 MM	10	17	16
	20	24	20
	40	34	28
	60	41	32
	80	48	33
2 x 10 MM	10	26	18
	20	37	24
	40	53	34
	60	65	39
	80	75	40

**NOTE:**

Standard length nozzles available in 8 MM & 10 MM.  
Extended range nozzles available in 10 MM & 12 MM.

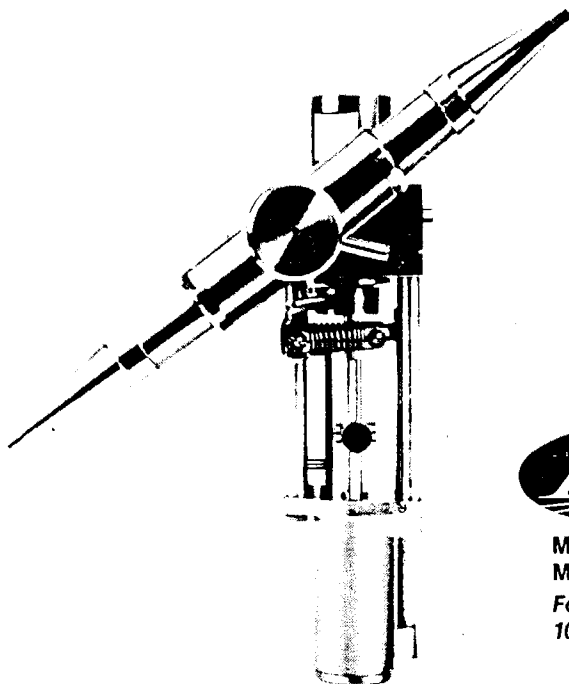
**ALSO AVAILABLE (Not Shown):**

**FURY Model 500 & FURY Model 700  
Open Tank Tankwashers**

For further information please contact  
our Sales Department.



**Model 600  
Mark IV**  
For Pressures  
40 to 260 psi



**SPECIFICATIONS:**

Cleaning radius ..... 28 to 66 ft.  
Flowrate ..... 34 to 194 gpm  
Weight ..... 22 lb.  
Nozzles ..... 8, 10 & 12mm  
Inlet ..... 1½"  
Overall length ..... 15¾"  
Operating temperature ..... 248°F. max.  
Min. opening req'd ..... 10" dia.

**MATERIALS:**

Stainless Steel ..... Type 304 & 440C  
Teflon ..... 25% carbon filled  
O-Rings ..... Nitrile

**PERFORMANCE DATA**

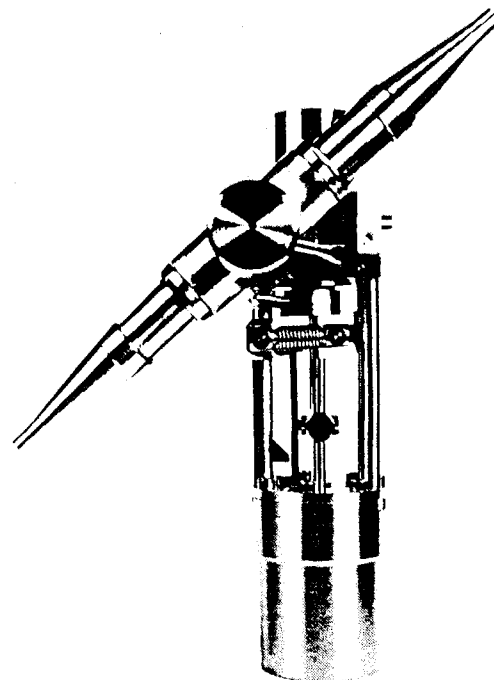
Nozzle Size MM	Pressure PSI	Flowrate GPM	Cleaning Radius FEET
2 x 8 MM <i>~35"</i>	40	34	28
	80	48	31
	120	58	33
	160	67	34
	200	75	35
	240	83	35
2 x 10 MM <i>~34"</i>	40	53	34
	80	75	40
	120	88	40
	160	102	38
	200	115	36
	240	120	32
2 x 12 MM <i>~42"</i>	40	76	41
	80	107	55
	120	131	59
	160	152	63
	200	169	65
	240	186	66

**NOTE:**

Standard length nozzles available in 8 MM & 10 MM.  
Extended range nozzles available in 10 MM & 12 MM.



**Model 610  
Mark IV**  
For Pressures  
10 to 80 psi



**SPECIFICATIONS:**

Cleaning radius ..... 16 to 55 ft.  
Flowrate ..... 17 to 107 gpm  
Weight ..... 26 lb.  
Nozzles ..... 8, 10 & 12mm  
Inlet ..... 1½"  
Overall length ..... 16"  
Operating temperature ..... 248°F. max.  
Min. opening req'd ..... 10" dia.

**MATERIALS:**

Stainless Steel ..... Type 304 & 440C  
Teflon ..... 25% carbon filled  
O-Rings ..... Nitrile

**PERFORMANCE DATA**

Nozzle Size MM	Pressure PSI	Flowrate GPM	Cleaning Radius FEET
2 x 8 MM	10	17	16
	20	24	20
	40	34	28
	60	41	32
	80	48	33
2 x 10 MM	10	26	18
	20	37	24
	40	53	34
	60	65	39
	80	75	40

**NOTE:**

Standard length nozzles available in 8 MM & 10 MM.  
Extended range nozzles available in 10 MM & 12 MM.

**ALSO AVAILABLE (Not Shown):**

**FURY Model 500 & FURY Model 700  
Open Tank Tankwashers**

For further information please contact  
our Sales Department.

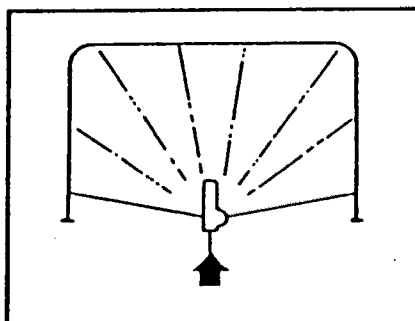
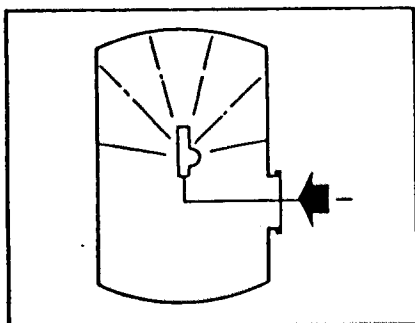
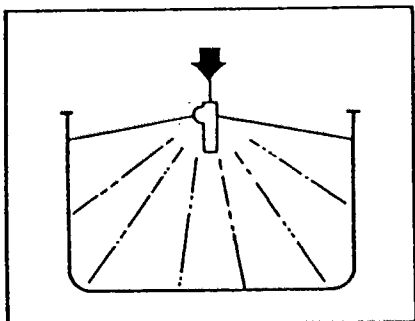


# Open Top Tankwasher

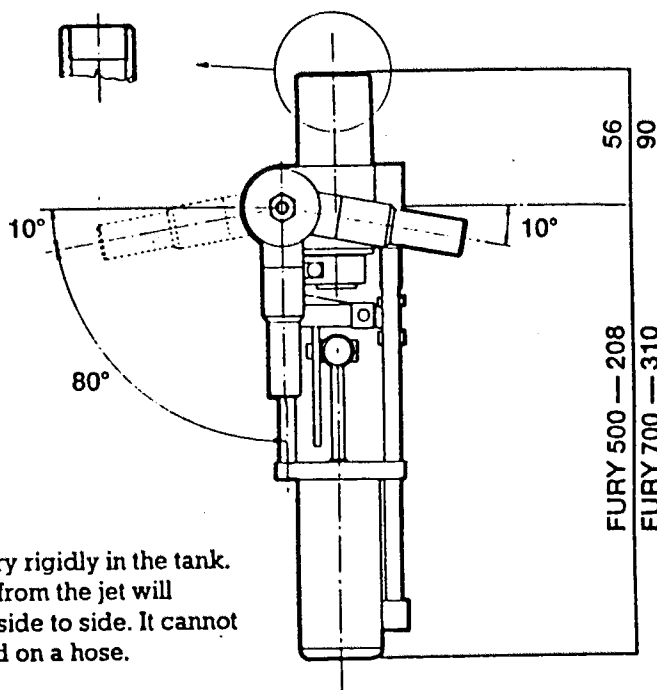
## TO CLEAN IN ONE DIRECTION ONLY

Often it is necessary to clean only one part of the tank such as a scumline, or if the tank has no top, to clean downwards only. Special Fury units have been developed to do this; they clean where needed and jetting is not wasted. Fermenting vessels in breweries are often open-topped. A single Fury mounted in the center of the tank will concentrate the jets on the yeast line and below.

Two Fury models are available of this type; the Fury 500 with four nozzles, the Fury 700 with two.



Mount the Fury rigidly in the tank. The reaction from the jet will move it from side to side. It cannot be suspended on a hose.



Model	Nozzle Size		Pressure		Flow Rate		Jet Radius	
	in	mm	psi	bar	gpm	l/min	ft	m
FURY 500	4x3/16	4x4.8	44	3	21	79	17	5
			73	5	27	102	20	6
			102	7	32	121	21	6.5
			131	9	36	137	23	7
	4x1/4	4x6.4	44	3	32	122	20	6
			73	5	42	157	23	7
			102	7	49	186	25	7.5
			131	9	56	211	26	8
FURY 700	2x5/16	2x8	44	3	34	127	26	8
			73	5	43	164	28	8.5
			102	7	51	193	30	9
			131	9	58	219	33	10
	2x25/64	2x10	44	3	52	198	31	9.5
			73	5	67	255	33	10
			102	7	80	302	36	11
			131	9	91	343	39	12

FURY 500 — 1 inch x 11½ NPT

FURY 700 — 1½ inch x 11½ NPT



**Chemdet**

*Advanced Ideas In Cleaning*

Chemdet, Inc. • 50 Sintsink Drive East, Port Washington, NY 11050 • Toll Free 1-800-645-1510, In New York 516-883-1510

# Turbodisc

## ROTATING DISC SUPER TANK CLEANING AT LOW PRESSURES AND LOW FLOW RATES

The TURBODISC is a scientifically-designed, self-operating cleaning device that provides a powerful dense spray to thoroughly clean your tank interiors, including all surfaces on the inlet tube above the cleaning head.

### CORROSION FREE

Made of high grade stainless steel, the TURBODISC is virtually corrosion free, so it can be used with a wide variety of chemicals and detergents at temperatures up to 248° F.

### SIMPLE DESIGN

With only one moving part, little or no maintenance is required. No small holes to block... the minimum orifice size is 1/8 inch.

### OIL-FREE OPERATION

No grease or oil lubrication is used. The cleaning fluid passing through the TURBODISC is the only lubrication necessary... ideal for the food and beverage industries.

### ECONOMY & EFFICIENCY

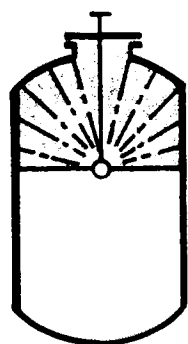
Low flow rates and reduced cleaning times are made possible by the continuous dense spray pattern created by the unique rotating disc design. The benefits are savings in time, energy, water consumption and disposable effluent.

TURBODISCs are available in two sizes and two spray patterns with a choice of threaded or butt weld connections. They can be mounted in any position to suit your application.



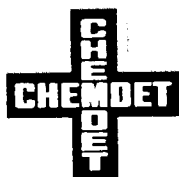
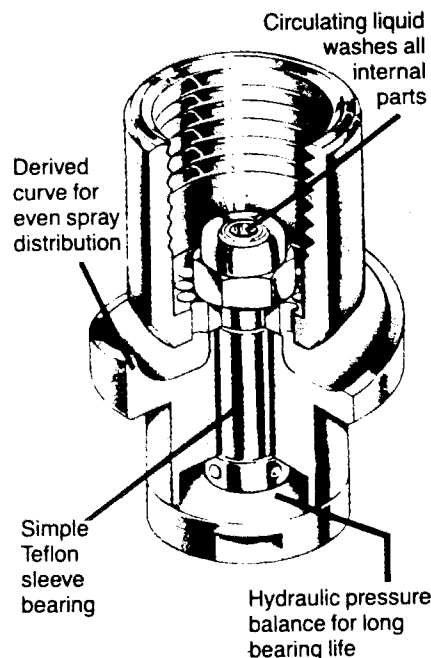
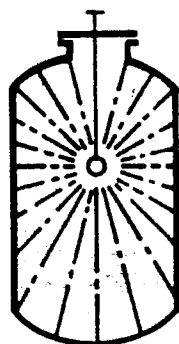
TURBODISC	MODEL 100	MODEL 150
Inlet Connection	1"	1½"
Disc Diameter	2"	2¾"
Maximum Temperature	248° F.	
Stainless Steel	Type 304	
Bearing Sleeve	Teflon 25% carbon filled	

MODELS 100/180° & 100/360°			MODELS 150/180° & 150/360°		
Pressure PSI	Flowrate GPM	Radius FT	Pressure PSI	Flowrate GPM	Radius FT
20	24.5	9	20	37.3	12
30	27.8	10	30	46.0	13
40	32.8	9	40	53.0	12
50	34.6	8	50	60.2	11
60	37.3	7	60	63.6	10



← TURBO 180° concentrates a dense spray above the Turbodisc unit in hard-to-clean areas.

TURBO 360° dispenses a dense all-around spray for complete coverage. →



## CHEMDET, Inc.

50 Sintsink Drive East  
Port Washington, N.Y. 11050

Toll-Free Tel. 800-645-1510; In New York 516-883-1510

Printed U.S.A.

EFFICIENT • ECONOMICAL • RELIABLE

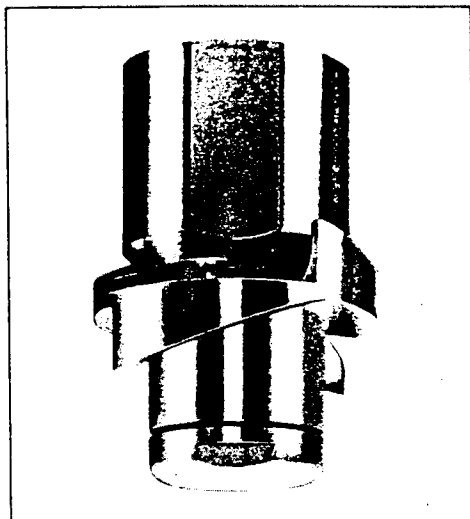
# TOTAL TANK CLEANING

CHEMDET TANK WASHERS FOR 100% VESSEL CLEANING • A COMPLETE RANGE FOR LARGE OR SMALL, OPEN OR CLOSED VESSELS

## TURBODISC

The Turbodisc tank washers from Chemdet present the highest level of cleaning technology available today. They are industry's first choice to replace outdated or ineffective cleaning and sanitation equipment.

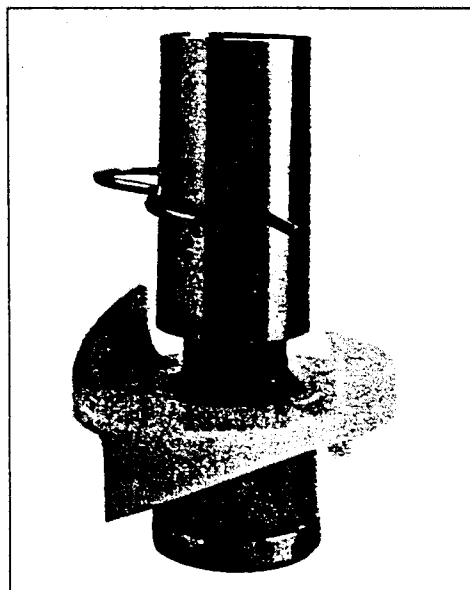
Turbodisc tank washers are designed to produce a dense all-around spray pattern and to operate at low pressures. Because Turbodiscs clean the entire tank interior at once, they clean more quickly and therefore use less liquid than competitive tank washers with the same flow rate. They are available in a 180° spray pattern for concentrated cleaning in one area of a tank or in a 360° pattern for all-around coverage.



## SANITARY 'S' TURBODISC

Chemdet's sanitary S-Turbodisc is especially designed for CIP tank cleaning applications in the food, dairy, beverage, cosmetic, pharmaceutical and similar industries. Made of stainless steel and approved plastic, the S-Turbodisc has only four parts held together with a single clip making cleaning or inspection simple and easy. This tank washer conforms to applicable FDA, USDA and 3A sanitary standards for materials in contact with foods, pharmaceuticals and dairy products.

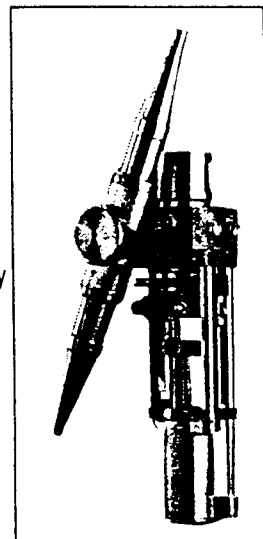
The S-Turbodisc Model 100-S operates at pressures from 20 to 60 PSI with a cleaning radius of 7 to 10 feet. The 150-S operates at the same pressure with a cleaning radius of 10 to 13 feet.



## FURY

Chemdet's Fury line of tank washers is the best solution to your most difficult tank cleaning problems. Fury models provide a high impact, concentrated rotating spray and are our most powerful units. They are primarily used for cleaning larger tanks and heavy, difficult to clean soils.

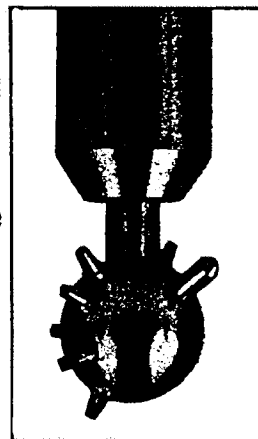
Constructed of stainless steel, Fury tank washers will withstand today's aggressive cleaning solutions, yet Fury washers use absolutely no oil or grease. Unlike most other tank washers, the Fury is not dependent on high internal flow rates and pressures. The Fury's speed of operation and cycle time can be fine tuned for maximum cleaning efficiency in minutes, regardless of the flow rate or pressure.



## ROTABALL

The ROTABALL's powerful jets and multiple cleaning patterns make it the ideal tank washer for cleaning applications requiring more impingement than a Turbodisc, but less than a Fury. The ROTABALL is self-operating. The flow of the cleaning fluid rotates the head at a steady pace to ensure maximum impact.

The speed of rotation is positively governed by a simple drive device using no gears. The ROTABALL is available in three spray head designs.



For further information on these or any other Chemdet product, contact your local Chemdet sales representative or call Chemdet, Inc.

Toll Free, 1-800-645-1510  
New York, 516-883-1510



**Chemdet**  
Advanced Ideas In Cleaning

50 Sintsink Drive East, Port Washington, NY 11050  
516-883-1510 In New York  
1-800-645-1510 Toll Free



**Chemdet**

*Advanced Ideas In Cleaning*

### FURY TANKWASHER PRICE LIST

FURY 400 MK IV TANKWASHER *	2050.00
1" Inlet, 2 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 1/8", 3/16", 1/4", 5/16"	
* Price with Kalrez o-rings (installed)	2275.00
FURY 400 MK V TANKWASHER **	2250.00
1" Inlet, 4 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 1/8", 3/16", 1/4", 5/16"	
** Price with Kalrez o-rings (installed)	2475.00
FURY 500 MK V OPEN-TOP TANKWASHER ***	2250.00
1" Inlet, 4 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 1/8", 3/16", 1/4", 5/16"	
*** Price with Kalrez o-rings (installed)	2475.00
FURY 600 MK IV TANKWASHER ****	3150.00
1-1/2" Inlet, 2 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 8 MM, 10 MM, 12 MM	
**** Price with Kalrez o-rings (installed)	4350.00
FURY 605 MK IV TANKWASHER	On Request
1-1/2" Inlet, 3 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 8 MM, 10 MM, 12 MM	
FURY 610 MK V TANKWASHER	On Request
1-1/2" Inlet, 2 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 8 MM, 10 MM, 12 MM	
FURY 700 MK IV OPEN-TOP TANKWASHER	3650.00
1-1/2" Inlet, 2 Nozzles, Stainless Steel Construction	
Standard Nozzle Sizes: 8 MM, 10 MM, 12 MM	

All prices in U.S. Dollars

Prices subject to change without notice

Chemdet reserves the right to correct any typographical errors

F.O.B. Port Washington, NY

Effective 3/15/91



**Chemdet**

*Advanced Ideas In Cleaning*

ROTABALL TANK WASHER PRICE LIST

1-1/2" STANDARD ROTABALL ..... 655.00

Model 1-1/2 SC - Top Entry - 1/2" Threaded Inlet

Model 1-1/2 SD - Base Entry - 1/2" Threaded Inlet

Model 1-1/2 SG - Open Top - 1/2" Threaded Inlet

2" STANDARD ROTABALL ..... 810.00

Model 2 SC - Top Entry - 3/4" Threaded Inlet

Model 2 SD - Base Entry - 3/4" Threaded Inlet

Model 2 SG - Open Top - 3/4" Threaded Inlet

MODEL 2SL SLOTTED HEAD ROTABALL ..... 815.00

2" EXTENDED THROW ROTABALL ..... 965.00

Model 2 XC - Top Entry - 3/4" Threaded Inlet

Model 2 XD - Base Entry - 3/4" Threaded Inlet

Model 2 XG - Open Top - 3/4" Threaded Inlet

3" STANDARD ROTABALL ..... 1235.00

Model 3 SC - Top Entry - 1-1/2" Threaded Inlet

Model 3 SD - Base Entry - 1-1/2" Threaded Inlet

Model 3 SG - Open Top - 1-1/2" Threaded Inlet

3" EXTENDED THROW ROTABALL ..... 1325.00

Model 3 XC - Top Entry - 1-1/2" Threaded Inlet

Model 3 XD - Base Entry - 1-1/2" Threaded Inlet

Model 3 XG - Open Top - 1-1/2" Threaded Inlet

All prices in U.S. Dollars

Prices subject to change without notice

Chemdet reserves the right to correct any typographical errors

F.O.B. Port Washington, NY

Effective 1/15/92



**Chemdet**

*Advanced Ideas In Cleaning*

THICK-WALL SPRAY BALL PRICE LIST

1-1/2" THICK-WALL SPRAY BALL ..... 175.00

Part #2340 - 3/8" Thread - 66 Holes - All Over Pattern (Ref. 7313)

Part #2341 - Pin Fitting - 66 Holes - All Over Pattern (Ref. 7221)

2" THICK-WALL SPRAY BALL ..... 225.00

Part #2350 - Pin Fitting - 67 Holes - All Over Pattern (Ref. 6957)

Part #2351 - Pin Fitting - 67 Holes - Top Pattern (Ref. 6942)

Part #2352 - 3/4" Thread - 67 Holes - All Over Pattern (Ref. 6951)

Part #2353 - 3/4" Thread - 63 Holes - Top Pattern (Ref. 6708)

2-1/2" THICK-WALL SPRAY BALL ..... 300.00

Part #2361 - Pin Fitting - 100 Holes - Top Pattern (Ref. 6928)

Part #2362 - Pin Fitting - 101 Holes - All Over Pattern (Ref. 6941)

Part #2363 - 3/4" Thread - 101 Holes - All Over Pattern (Ref. 6958)

Part #2365 - 3/4" Thread - 101 Holes - Top Pattern (Ref. 6907)

3" THICK-WALL SPRAY BALL ..... 325.00

Part #2372 - Pin Fitting - 151 Holes - All Over Pattern (Ref. 6950)

Part #2373 - Pin Fitting - 151 Holes - Top Pattern (Ref. 7016)

Part #2374 - 3/4" Thread - 151 Holes - All Over Pattern (Ref. 7329)

Part #2375 - 3/4" Thread - 151 Holes - Top Pattern (Ref. 6908)

Part #2376 - 1" Thread - 151 Holes - All Over Pattern (Ref. 7329)

All prices in U.S. Dollars

Prices subject to change without notice

Chemdet reserves the right to correct any typographical errors

F.O.B. Port Washington, NY

Effective 1/15/92



**Chemdet**

*Advanced Ideas In Cleaning*

**TURBODISC TANKWASHER PRICE LIST**

---

**BEARING STYLE**

TURBODISC 100 (Special Order Item) ..... On Request  
1" Threaded Inlet, 2-1/4" OD Disc, 304 SS With 440C SS Bearings

TURBODISC 150 (Special Order Item) ..... On Request  
1-1/2" Threaded Inlet, 2-3/4" OD Disc, 304 SS With 440C SS Bearings

**SANITARY STYLE**

TURBODISC 100-S ..... 230.00  
1" OD Tube Inlet, 2-1/2" OD Disc, 316 SS & Kynar

TURBODISC 150-S ..... 285.00  
1-1/2" OD Tube Inlet, 3-1/4" OD Disc, 316 SS & Kynar

**SLEEVE STYLE**

TURBODISC 28/360 ..... 285.00  
1/4" Threaded Inlet (Male), 1.10"/28mm OD Disc, 316 SS & PTFE  
TURBODISC 28/360 WITH PROTECTIVE CAGE ..... 570.00

TURBODISC 75/360 ..... 320.00  
3/4" Threaded Inlet, 1-1/2" OD Disc, 304 SS & PTFE  
TURBODISC 75/360-316 (Special Order Item - Type 316 SS) ..... 365.00

TURBODISC 100/180 ..... 320.00  
1" Threaded Inlet, 2" OD Disc, 304 SS & PTFE  
TURBODISC 100/180-316 (Special Order Item - Type 316 SS) ..... 370.00

TURBODISC 100/360 ..... 320.00  
1" Threaded Inlet, 2" OD Disc, 304 SS & PTFE  
TURBODISC 100/360-316 (Special Order Item - Type 316 SS) ..... 370.00

TURBODISC 150/180 ..... 400.00  
1-1/2" Threaded Inlet, 2-3/4" OD Disc, 304 SS & PTFE  
TURBODISC 150/180-316 (Special Order Item - Type 316 SS) ..... 475.00

TURBODISC 150/360 ..... 400.00  
1-1/2" Threaded Inlet, 2-3/4" OD Disc, 304 SS & PTFE  
TURBODISC 150/360-316 (Special Order Item - Type 316 SS) ..... 475.00

All prices in U.S. Dollars

Prices subject to change without notice

Chemdet reserves the right to correct any typographical errors

F.O.B. Port Washington, NY

Effective 1/15/92

**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

**RECORD OF TELEPHONE CONVERSATION**

DATE 2-27-92

TIME 2:30 P

PAGE 1 OF 1

FROM: <u>MYRON SCHULTZ</u>	TO: <u>ALLISON BUHL</u>
COMPANY: <u>UE&amp;C</u>	COMPANY: <u>SPRAYING SYSTEMS, INC</u> <u>LOCAL REP. ALBUHL ASSOC.</u>
PHONE: <u>303-843-2454</u>	PHONE: <u>303-830-9002</u>
REFERENCE/PROJECT NO.: <u>6299.001, NREL</u>	
SUBJECT: <u>FERMENTING / DIGESTER TANKS</u> <u>C.I.P. SYSTEM - SPRAY NOZZLES.</u>	

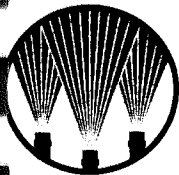
TOPICS OF CONVERSATION: \_\_\_\_\_

SPRAYING SYSTEMS INC. PRODUCES TANK WASHING MACHINES  
THAT COULD BE USED FOR OUR APPLICATION.

ALLISON WILL GET BACK TO ~~BE~~ ME WITH A SPECIFIC  
RECOMMENDATION FOR OUR TANKS, AND WILL SEND ME AN  
UPDATED PRODUCT CATALOG.

DISTRIBUTION

FORM 62-20  
REVISED 5/85



# Spraying Systems Co.

March 18, 1992

Mr. Myron Schultz  
United Engineers & Constructors  
P.O. Box 5888  
Denver, CO 80217

Re: Ethanol Plant Project, tank washing

Dear Myron:

Per our conversation of this morning we are pleased to quote the following:

Spraying Systems Co. quotation #7499+2

<u>Quantity</u>	<u>Part Number</u>	<u>Price Each</u>	<u>Delivery</u>
1	23445-290A-6-2	\$5473.07	10-12 weeks
20	23445-290A-6-2	\$3697.80	10-12 weeks
140	23445-290A-6-2	\$3601.24	10-12 weeks

Prices on the above special items are valid for 60 days.

The following item, the AA190A-6 (for possible use in a scaled down pilot project), is a standard item and carries standard pricing:

Part Number	Price each in lots of		
	<u>1</u>	<u>2-5</u>	<u>6-11</u>
AA190A-6	\$2272.73	2026.34	1895.53

Pricing on this standard tank wash unit will hold firm at least through 1992.

Our terms are net 30 days. As I mentioned, terms may be modified on a special basis to facilitate testing.

F.O.B. Wheaton, Illinois.

I have requested data to confirm the 50' throw radius of the AA290A-6-2 equipped with our H3/4U-00700 solid stream VeeJet nozzles.

I will be on vacation next week and will contact you the week of April 6 to go over the data.

Please call our Denver office when we may be of further service.

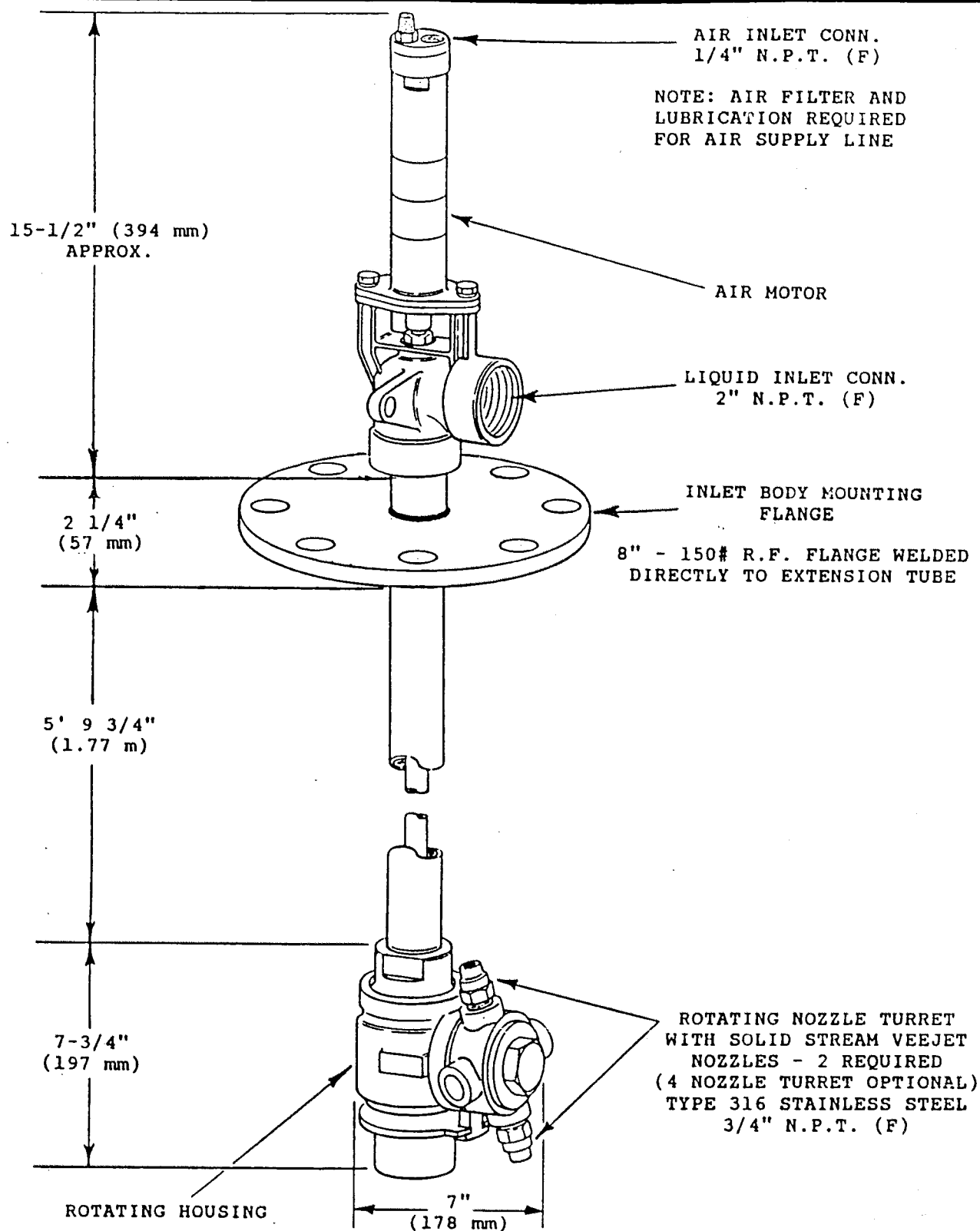
Yours very truly,

  
Allison Buhl  
Representative

enc.

*Saving you time, money and energy through our spray nozzle expertise and applications experience*

Represented by: **AL BUHL & ASSOCIATES/ALLISON BUHL**  
1600 Broadway - #2035, Denver, CO 80202 • Tel: 303-830-9002 • FAX: 303-830-9373



# DESCRIPTION

NO. 23445-290A-6-2  
AIR MOTOR DRIVEN  
ROTARY TANK WASHER

## Spraying Systems Co.

Spray Nozzles and Accessories

North Avenue and Schmale Road, Wheaton, Illinois 60188

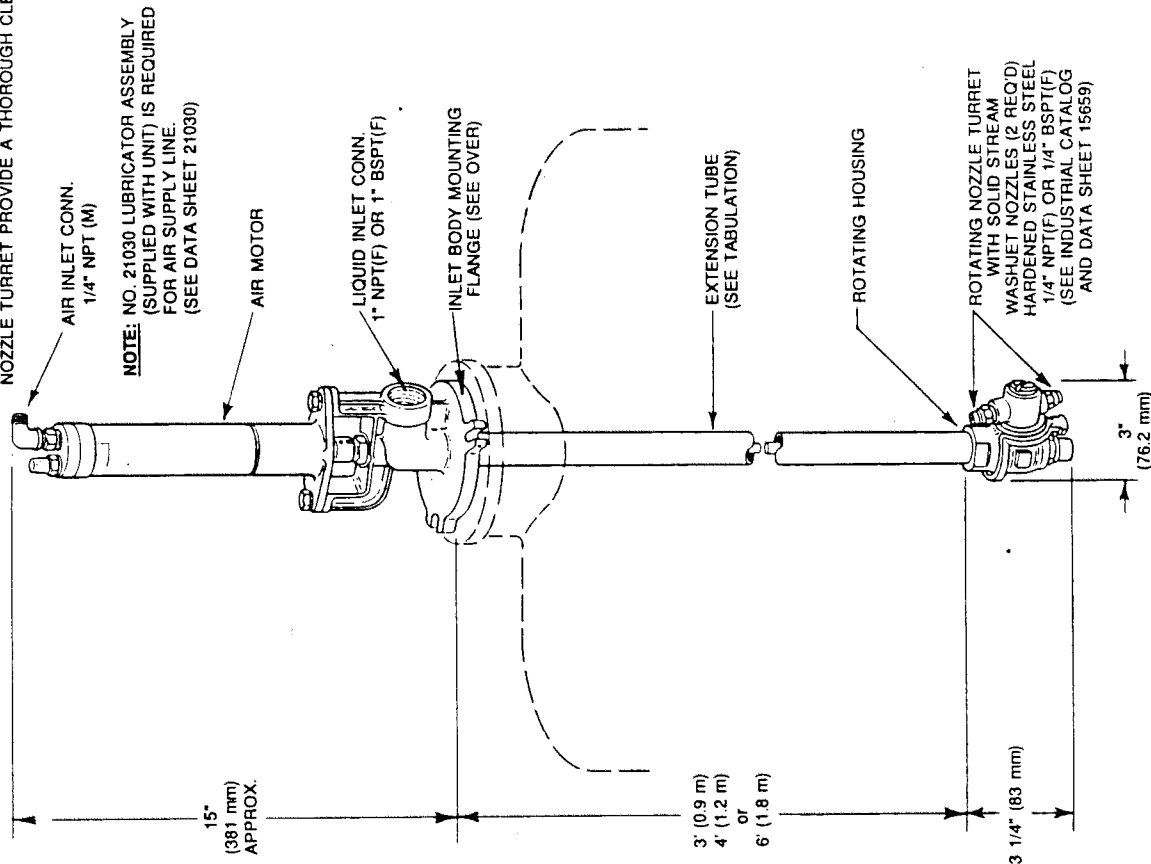
Ref :

Revision No.

Data Sheet No.

23445

THE AA190A-AIR MOTORIZED ROTARY TANK WASHER PROJECTS CLEANING SOLUTION IN CONCENTRATED HIGH IMPACT, SOLID STREAM SPRAYS...WITH ROTATING MOTION THAT COVERS ALL INTERNAL SURFACES OF TANKS. SLOW, CONTROLLED ROTATIONAL SPEEDS OF ROTATING HOUSING AND NOZZLE TURRET PROVIDE A THOROUGH CLEANING ACTION ON THE TANK SURFACE.



#### FEATURES

- CAN BE USED AS A PERMANENTLY INSTALLED UNIT OR PORTABLE UNIT.
- NOZZLE TURRET WITH 2 SOLID STREAM NOZZLES IS GEAR DRIVEN TO GIVE FULL COVERAGE OF INTERNAL TANK SURFACES.
- ENTIRE DRIVING UNIT IS MOUNTED OUTSIDE OF THE TANK.
- ROTATIONAL SPEED OF THE NOZZLE TURRET IS INDEPENDENT OF THE CLEANING LIQUID PRESSURE AND FLOW.
- FOR TANK DIAMETERS UP TO APPROXIMATELY 12 FT. (3.7 m).
- FOR SPECIFICATIONS AND ADDITIONAL INFORMATION, SEE DATA SHEET 190A-1 (OVER) AND BULLETIN NO. 285.
- MAXIMUM PRESSURE 500 psi (35 bar).

ROTARY TANK WASHER NO.	EXTENSION LENGTH	WEIGHT
AA_190A-3+ *	3' (0.9 m)	11 LBS. (5 kg)
AA_190A-4+ *	4' (1.2 m)	12 1/2 LBS. (5.7 kg)
AA_190A-6+ *	6' (1.8 m)	15 1/2 LBS. (7 kg)

\* SPECIFY SOLID STREAM NOZZLE NO. - AND MATERIAL SUCH AS: 1/4MEG-0030, HARDENED STAINLESS STEEL.

FOR BSPT CONNECTION MODELS, ADD "B" TO THE WASHER NO. AND NOZZLE NO. SUCH AS AAB190A-3+B1/4MEG-0030.

#### DESCRIPTION

AA190A-AIR MOTORIZED  
ROTARY TANK WASHER

**Spraying Systems Co.**

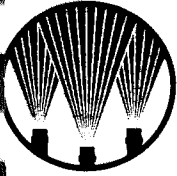
Spray Nozzles and Accessories  
North Avenue and Schmels Road  
Wheaton, Illinois 60188

Data Sheet No.

Ref :

Revision No. 6

**190A**



# Spraying Systems Co.

---

March 6, 1992

Mr. Myron Schultz  
United Engineers & Constructors  
P. O. Box 5888  
Denver, CO 80217

Dear Myron:

Referencing our recent conversations regarding the proposed ethanol processing plant we would like to propose for you consideration our AA290A RotoJet tank washing unit.

The RotoJet tank wash unit utilizes an external air motor to drive the two (can be retrofitted to four) high impact solid stream nozzles. This external drive makes turret speed independant of water pressure and minimizes many of the wear pionsnts associated with hydraulically driven units.

This unit can also be taylored to each tank's individual needs by using different capacity impact nozzles depending on the vessel's size. Your largest tank could utilize our largest nozzles, delivering 204 GPM at 100 psi for over a 50' spray radius. The smaller tanks would use smaller nozzles delivering only 108 GPM at 100 psi while still providing a 40' spray radius.

Three of our AA290A tank wash units were purchased for UE&C's work on the Sweeney Environmental Control Unit in 1989. These units were purchased for vertical top mount installation. Some of the names I have found who were involved with this project are as follow:

Bob Leise -- Buyer, UE&C  
H.D. Newberry -- On site manager, UE&C, the units were shipped to his attention  
Earl Powell -- Quality Assurance Supervisor, UE&C  
C.E. Hassert -- Quality Assurance, Phillips Petroleum Company  
Myron Schultz -- Project Engineer, you called requesting information on the amount of assembly UE&C would have to do, 10/10/88.

I have included several drawings form this 1988-89 project.

We feel these two hard hitting solid stream nozzles will do an excellent job of cutting through the saw dust like build up on the vessle floors. With the high flow rate provided this will flush the debris to the lowered drain.

I have also included information on our smaller RotoJet, the AA190A unit. This 20 GPM version may be ideal for your pilot project.

*Saving you time, money and energy through our spray nozzle expertise and applications experience*

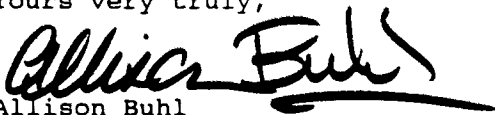
Represented by: **AL BUHL & ASSOCIATES/ALLISON BUHL**  
1600 Broadway - #2035, Denver, CO 80202 • Tel: 303-830-9002 • FAX: 303-830-9373

*Spraying Systems Co.*

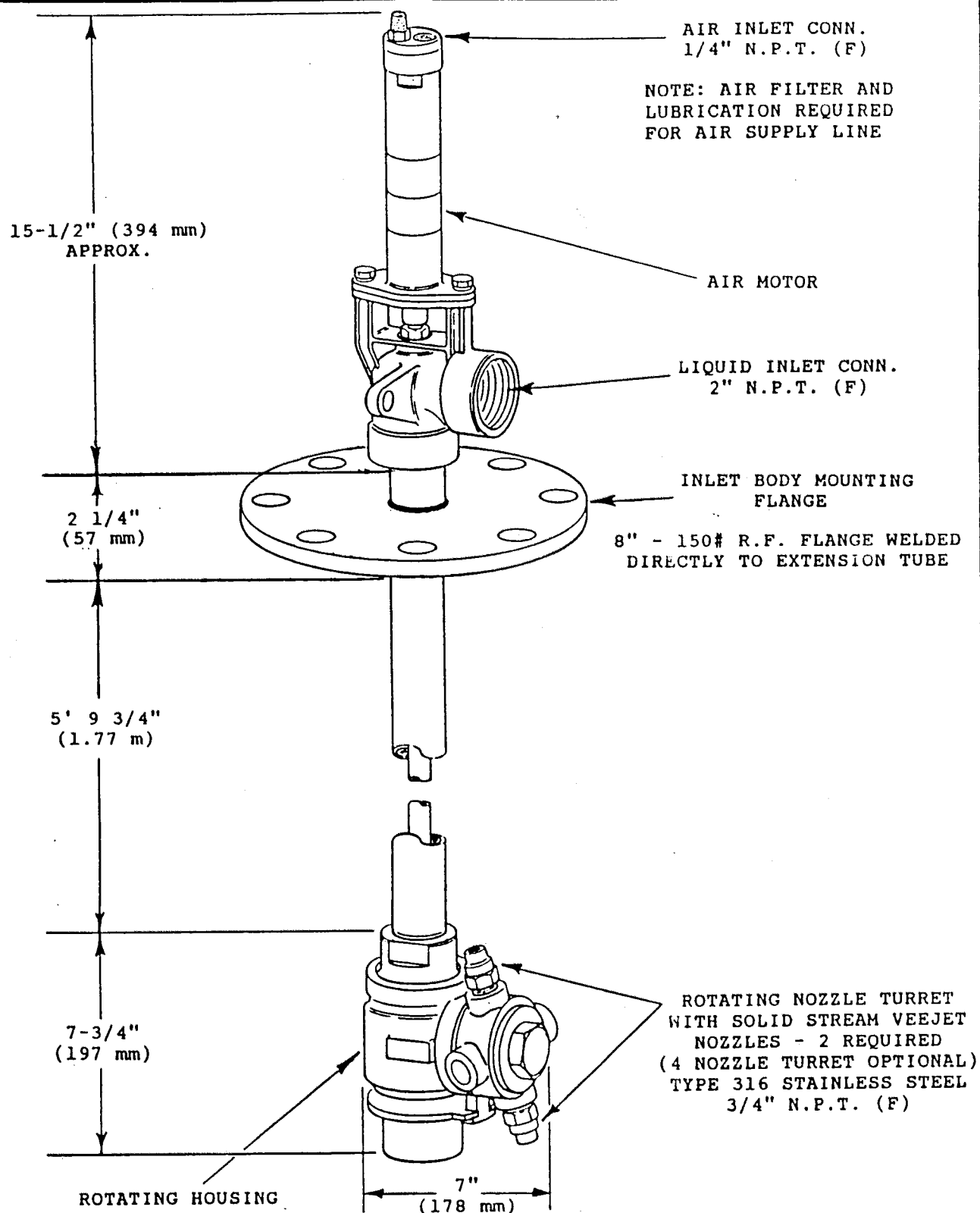
A request for quotation has been entered. I will forward the pricing of both units early next week.

We appreciate your interest in our product line. Please call our Denver office when we may be of further service.

Yours very truly,

  
Allison Buhl  
Representative

enc.



#### DESCRIPTION

NO. 23445-290A-6-2  
AIR MOTOR DRIVEN  
ROTARY TANK WASHER

## Spraying Systems Co.

Spray Nozzles and Accessories

North Avenue and Schmale Road, Wheaton, Illinois 60188

Ref :

Revision No.

Data Sheet No.

23445

**EQUIPMENT DATA SHEET**

ITEM NUMBER

PAGE

☒ INQUIRY ☐ PROPOSAL ☐ STUDY ☐ PROJECT

61-316,318 &amp; 320

1 OF 2

## CUSTOMER &amp; LOCATION

## PROJECT

## JOB / INQUIRY NO.

## DATE:

 PHILLIPS PETROLEUM  
OLD OCEAN, TEXAS

 SWEENEY ENVIRONMENTAL  
CONTROL UNIT

8724001

5-17-88

## ACCOUNT NO.

## BY:

MS/WJD/c

 REVISIONS  
(Date & By)

 A  
E

 B  
F

 C  
G

 D  
H

## SERVICE

TANK CLEANING NOZZLES

## MANUFACTURER

## NO. REQ.

3

## SOURCE OF QUOTE

Spray nozzles to provide for solvent cleaning of all interior surfaces of (3) Feedstock Storage Tanks are to be provided.

The Feedstock Storage Tanks are used for storage of various hydrocarbon waste streams.

Each tank is to have its own spray nozzles, permanently mounted via blind flanges to tank nozzles. The spray nozzle quantity, locations, and required tank nozzle size for mounting are all to be as recommended by the vendor.

If required, the spray heads may be air motor driven, in which case they will be furnished complete with lubricator and filter regulator.

The nozzles will be completely immersed in the tank liquids which may contain up to 40 wt. % solids. The tanks will be drained prior to cleaning and rinsing, and only one tank will be cleaned at a time.

System Design Data is as follows:

Tank Operating Temperature	180°F
Tank Operating Pressure	2 PSIG
Cleaning Solution	KEROSENE OR EQUAL
Solution Pressure	75 PSIG
Solution Flowrate	200 GPM/TANK
Air Pressure Available	90 PSIG

See Page 2 of 2 for Tank Dimensions

Vendor furnish the following information with Bid:

No. of Spray Nozzles Required Per Tank  
 Dimensions "A" and "B" shown on p. 2  
 Spray Nozzle Model No.  
 Tank Nozzle Size and No. Required  
 Materials of Construction  
 Air Consumption Per Spray Nozzle UNIT  
 Solvent Flow Rate Per Nozzle UNIT  
 Solvent Pressure Required  
 Estimated Weight/Spray Nozzle Assembly

\*

\*\*

(1) OR (2)

SEE PAGE 2

" " "

316SS / TEFLON

12

SCFM

\* 170 \*\* 90 GPM

70

PSIG

\* 56 \*\* 43 LB

Furnish quotations for (2) systems as follows:

1. Vertical, top head mounted system. — \*
2. Alternate, horizontal, shell mounted system. — \*\*

United Engineers  
& Constructors

## EQUIPMENT DATA SHEET

ITEM NUMBER

PAGE

2

☒ INQUIRY ☐ PROPOSAL ☐ STUDY ☐ PROJECT

61-316,318,320

OF

CUSTOMER & LOCATION  
PHILLIPS PETROLEUM  
OLD OCEAN, TXPROJECT  
SWEENEY ENVIRONMENTAL  
CONTROL UNITS-A JOB/INQUIRY NO.  
8724001

DATE: 5-17-88

ACCOUNT NO.

BY: MRS

REVISIONS  
(Date & By)

A

E

B

F

C

G

D

H

SERVICE

TANK CLEANING NOZZLES

MANUFACTURER

SPRAYING SYSTEMS CO.

NO. REQ'D.

3

SOURCE OF QUOTE

\* (1) AA290A-6-2  
+ (2) H 3/4 U-316SS

00700

FLOW RATE  
PER UNIT170 GPM  
AT 70 PSIAIR MOTOR DRIVE C/W LUBRICATOR &  
FILTER REGULATOR - IF A MOTOR DRIVEN  
SPRAY NOZZLE IS REQ'D.VERTICAL, TOP HEAD MOUNT  
SYSTEM

MAX LIQUID LEVEL

- ALTERNATE -  
HORIZONTAL, SHELL  
MOUNT SYSTEM.

13'-0" I.D.

DIM. "B"  
IF REQ'D.\*\*  
(2) AA290A-3-  
2 + (2) H 3/4 U-  
316SS 00350  
PER UNITFLOW RATE  
PER UNIT  
90 GPM  
AT 70 PSI

HEATING COIL

5'-6" MIN.  
DIM "A"

60°

FEEDSTOCK STORAGE TANK

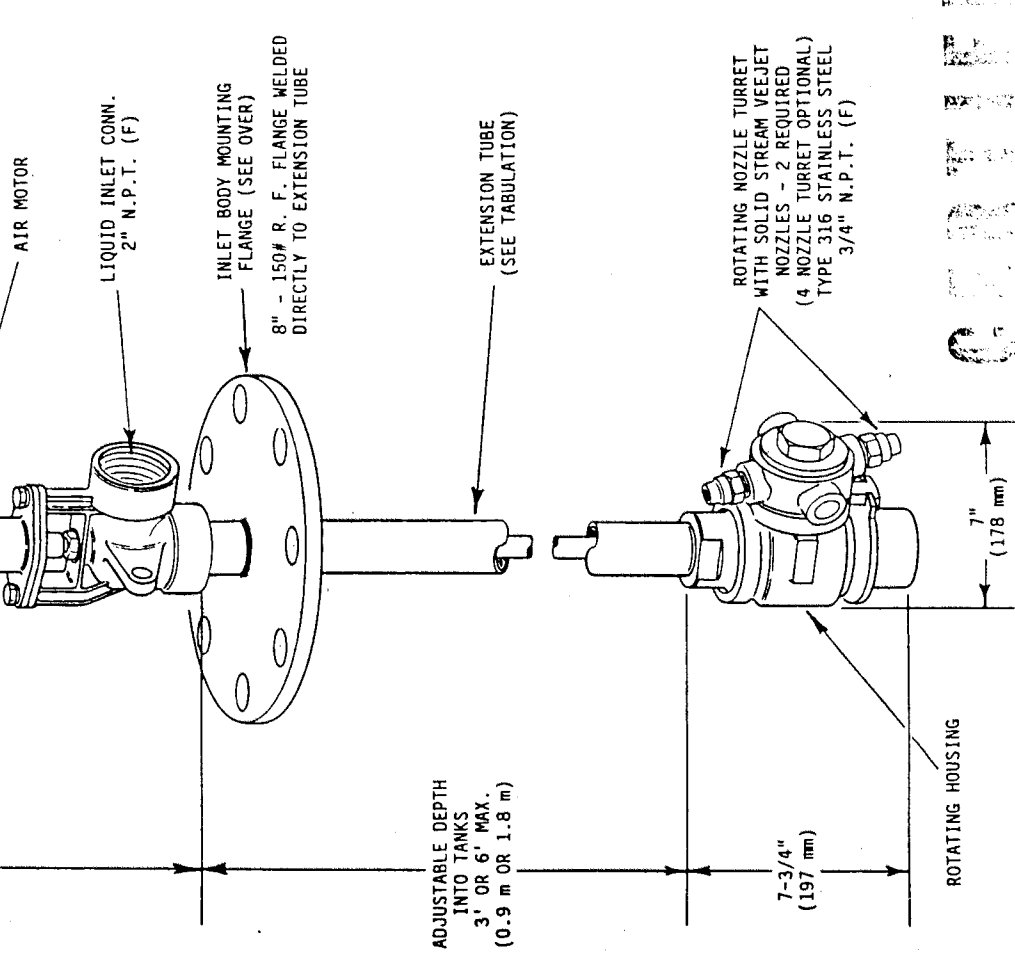
(1) SHOWN - (3) REQUIRED

THE AA290A-- AIR MOTOR DRIVEN ROTARY TANK WASHER PROJECTS CLEANING SOLUTION IN CONCENTRATED  
IMP. SOLID SPR. WITH ING M. THAT S ALL. AL. THER. ES  
OF TANKS. SLOW. CONTROLLED ROTATIONAL SPEEDS OF ROTATING HOUSING AND NOZZLE TURRET  
PROVIDE A THOROUGH CLEANING ACTION ON THE TANK SURFACE.

AIR INLET CONN.  
N.P.  
NOTE: AIR FILTER AND  
LUBRICATION REQUIRED  
FOR AIR SUPPLY LINE

- FEATURES:**
- CAN BE USED AS A PERMANENTLY INSTALLED UNIT OR REMOVABLE UNIT.
  - EXTENSION INTO TANK IS FULLY ADJUSTABLE.
  - NOZZLE TURRET WITH 2 OR 4 SOLID STREAM NOZZLES IS GEAR DRIVEN TO GIVE FULL COVERAGE OF INTERNAL TANK SURFACES.
  - ENTIRE DRIVING UNIT IS MOUNTED OUTSIDE OF THE TANK.
  - ROTATIONAL SPEED OF THE NOZZLE TURRET IS INDEPENDENT OF THE CLEANING LIQUID PRESSURE AND FLOW.
  - FILTER, REGULATOR/LUBRICATOR SUPPLIED WITH UNIT.
  - FOR TANK DIAMETERS UP TO APPROXIMATELY 40 FT. (12.2 m).
  - FOR SPECIFICATIONS AND ADDITIONAL INFORMATION, SEE DATA SHEET 290A-1 (OVER).

15-1/2" (394 mm)  
APPROX.



ROTARY TANK WASHER NO.	EXTENSION LENGTH	WEIGHT
AA290A-3	3' (0.9 m)	43 LBS. (19.5 kg)
AA290A-6	6' (1.8 m)	56 LBS. (25.5 kg)

DESCRIPTION

AA290A-- AIR MOTOR DRIVEN  
ROTARY TANK WASHER

**Spraying Systems Co.**

Spray Nozzles and Accessories

North Avenue and Schmale Road  
Wheaton, Illinois 60188

Ref :

Revision No.

Data Sheet No.

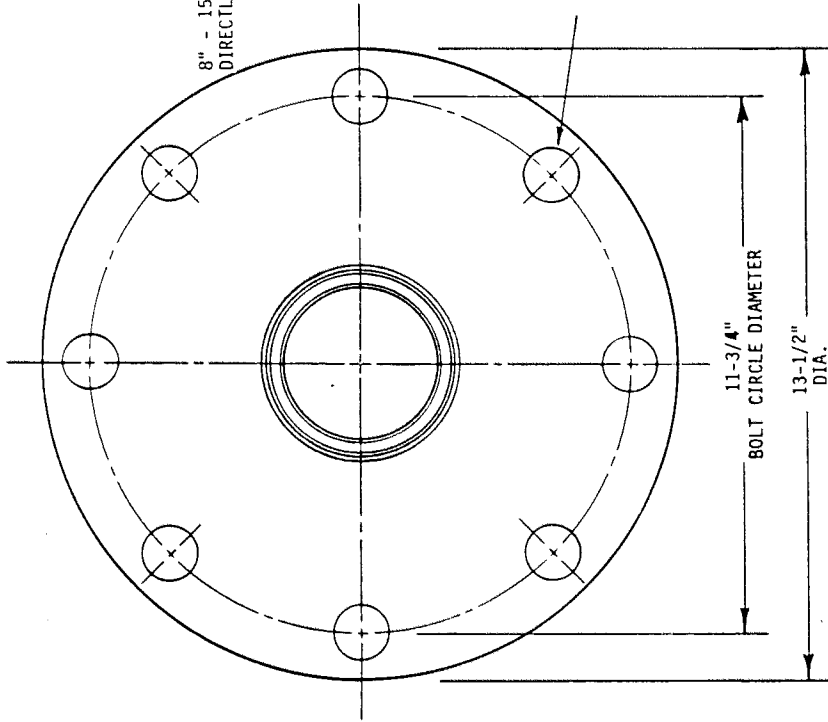
**290A**

COPYRIGHTED

SPRAYING SYSTEMS CO.

WHEATON, ILLINOIS

DATE 12/12/88 BY WWS



BOTTOM VIEW OF INLET BODY MOUNTING FLANGE

**SPECIFICATIONS:**

- WETTED PARTS ARE TEFLON AND TYPE 316 STAINLESS STEEL.
- MAXIMUM PRESSURE - 250 P.S.I. (17 bar)
- MAXIMUM RECOMMENDED FLOW - 260 G.P.M. (984 l/min.)
- MAXIMUM LIQUID TEMPERATURE - 200° F. (93° C)
- PRESSURE LOSS - 22 P.S.I. (1.5 bar) AT 250 GPM (930 l/min)
- SPRAY HEAD FITS THROUGH A 7" (178 mm) DIAMETER HOLE.

PRESSURE AT MOTOR P.S.I. (bar)	SPEED R.P.M. *	AIR CONSUMPTION		CYCLE (MIN.) **
		SCFM	l/sec.	
30	2.1	5	2	19
60	4.1	9	4	14
90	6.2	12	6	13

\*ASSUMING EXHAUST FILTER IS CLEAN.  
\*\*61 REVOLUTIONS ARE REQUIRED FOR 1 COMPLETE CYCLE.

**FLOW RATE DATA**

— ENGLISH UNITS —

TOTAL FLOW OF 2 NOZZLES (EQUAL CAPACITY) GALLONS PER MINUTE					
NOZZLE H3/4U-	LIQUID INLET PRESSURE				
	50 P.S.I.	100 P.S.I.	150 P.S.I.	200 P.S.I.	250 P.S.I.
00100	22	32	39	45	50
00250	55	78	96	111	124
00350	77	108	133	153	171
00500	107	151	185	214	239
00700	144	204	250	-	-

— METRIC UNITS —

TOTAL FLOW OF 2 NOZZLES (EQUAL CAPACITY) LITERS PER MINUTE					
NOZZLE H3/4U-	LIQUID INLET PRESSURE				
	3.5 bar	7 bar	10 bar	15 bar	17 bar
00100	85	120	144	176	190
00250	210	300	355	435	465
00350	290	410	495	605	645
00500	410	575	690	845	900
00700	550	780	930	-	-

**DESCRIPTION**

SPECIFICATIONS FOR  
AA290A-- AIR MOTOR DRIVEN  
ROTARY TANK WASHER

**Spraying Systems Co.**

Spray Nozzles and Accessories  
North Avenue and Schmale Road  
Wheaton, Illinois 60188

Ref : \_\_\_\_\_ Data Sheet No.

Revision No.

**290A-1**

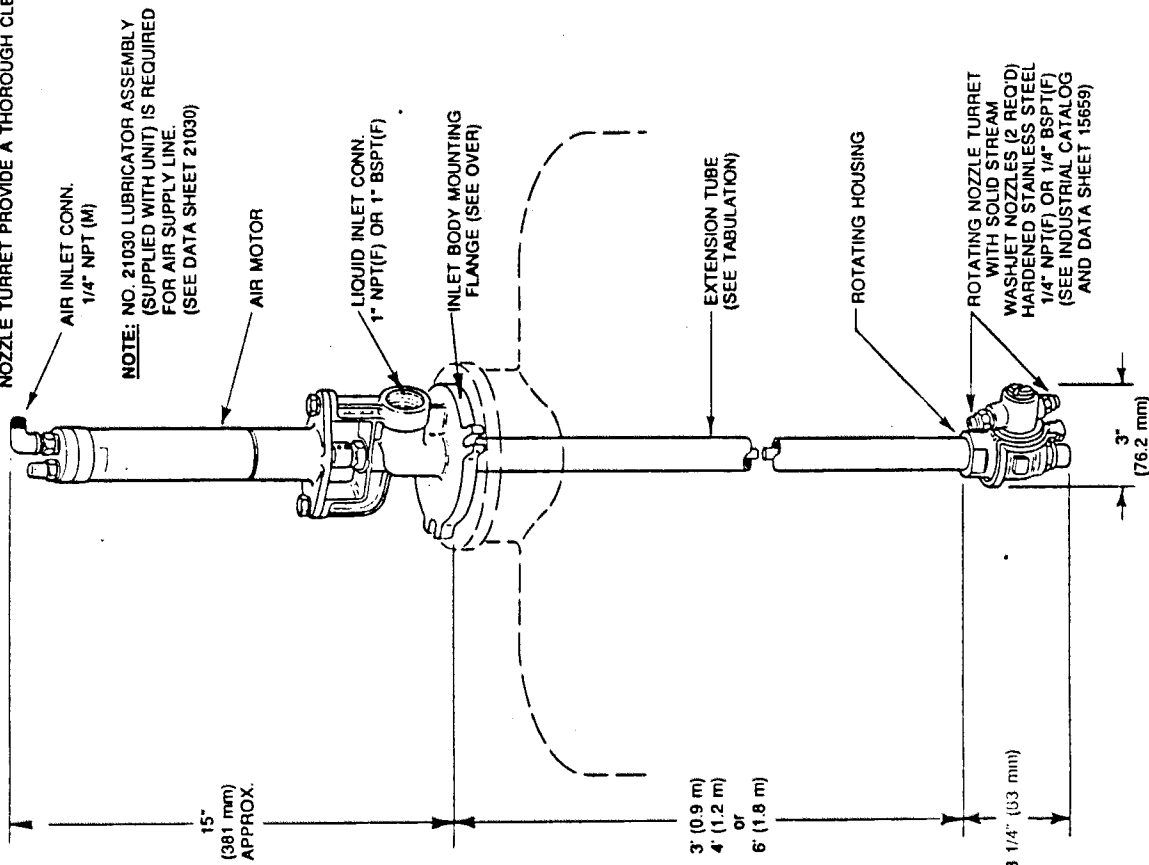
**CERTIFIED**

**SPRAYING SYSTEMS CO.**

WHEATON, ILLINOIS

DATE 12/12/88 BY WWS

THE AA190A-AIR MOTORIZED ROTARY TANK WASHER PROJECTS CLEANING SOLUTION IN CONCENTRATED HIGH IMPACT, SOLID STREAM SPRAYS...WITH ROTATING MOTION THAT COVERS ALL INTERNAL SURFACES OF TANKS. SLOW, CONTROLLED ROTATIONAL SPEEDS OF ROTATING HOUSING AND NOZZLE TURRET PROVIDE A THOROUGH CLEANING ACTION ON THE TANK SURFACE.



#### FEATURES

- CAN BE USED AS A PERMANENTLY INSTALLED UNIT OR PORTABLE UNIT.
- NOZZLE TURRET WITH 2 SOLID STREAM NOZZLES IS GEAR DRIVEN TO GIVE FULL COVERAGE OF INTERNAL TANK SURFACES.
- ENTIRE DRIVING UNIT IS MOUNTED OUTSIDE OF THE TANK.
- ROTATIONAL SPEED OF THE NOZZLE TURRET IS INDEPENDENT OF THE CLEANING LIQUID PRESSURE AND FLOW.
- FOR TANK DIAMETERS UP TO APPROXIMATELY 12 FT. (3.7 m).
- FOR SPECIFICATIONS AND ADDITIONAL INFORMATION, SEE DATA SHEET 190A-1 (OVER) AND BULLETIN NO. 285.
- MAXIMUM PRESSURE 500 psi (35 bar).

ROTARY TANK WASHER NO.	EXTENSION LENGTH	WEIGHT
AA_190A-3+ *	3' (0.9 m)	11 LBS. (5 kg)
AA_190A-4+ *	4' (1.2 m)	12 1/2 LBS. (5.7 kg)
AA_190A-6+ *	6' (1.8 m)	15 1/2 LBS. (7 kg)

- SPECIFY SOLID STREAM NOZZLE NO. - AND MATERIAL SUCH AS: 1/4MEG-0030, HARDENED STAINLESS STEEL.
- FOR BSPT CONNECTION MODELS, ADD "B" TO THE WASHER NO. AND NOZZLE NO. SUCH AS AA190A-3+B1/4MEG-0030.

## Spraying Systems Co.

Spray Nozzles and Accessories  
North Avenue and Schmale Road  
Wheaton, Illinois 60188

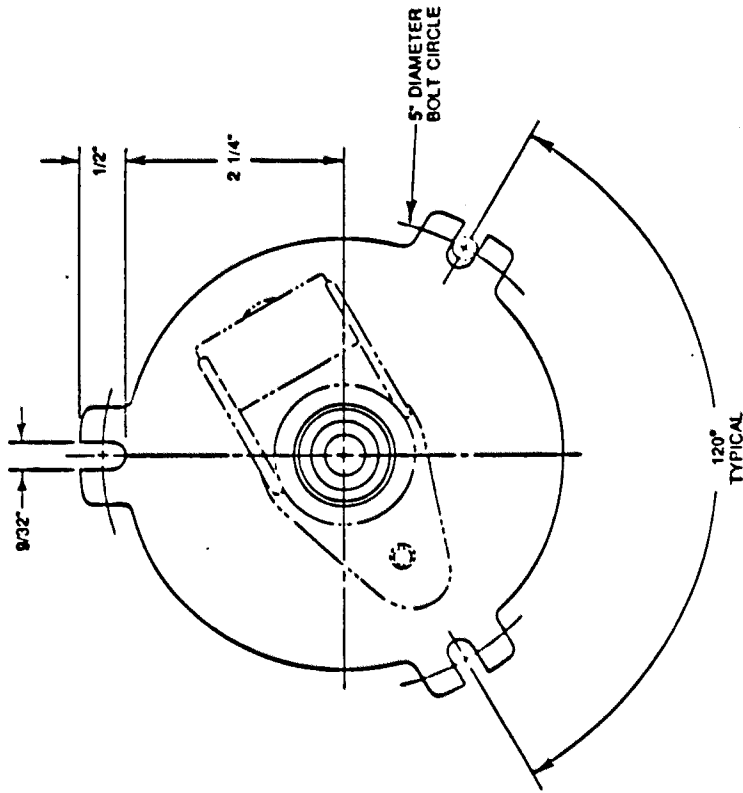
Data Sheet No.

190A

Ref :

Revision No. 6

AA190A-AIR MOTORIZED  
ROTARY TANK WASHER



**BOTTOM VIEW OF INLET BODY MOUNTING FLANGE**

**SPECIFICATIONS**

- WETTED PARTS ARE TEFロン AND TYPE 316 STAINLESS STEEL.
- MAXIMUM PRESSURE - 500 P.S.I. (35 bar).
- MAXIMUM RECOMMENDED FLOW - 20 G.P.M. (76 l/min).
- MAXIMUM LIQUID TEMPERATURE - 200° F (93° C).
- PRESSURE LOSS - 40 P.S.I. (2.8 bar) AT 20 G.P.M. (76 l/min).
- SPRAY HEAD FITS THROUGH A 3 1/2" (89 mm) DIAMETER HOLE.

**AIR MOTOR DATA**

AIR PRESSURE AT MOTOR PSI	APPROX. SPEED RPM*	AIR CONSUMPTION SCFM	1 COMPLETE CYCLE (MIN.)**
30	3.9	5	9
60	4.8	9	6
90	5.3	12	7

\*Assuming both exhaust filters are clean.  
 \*\*35 revolutions are required for 1 complete cycle.

**FLOW RATE DATA**

TOTAL FLOW OF 2 NOZZLES (EQUAL CAPACITY) GALLONS PER MINUTE				
NOZZLE SIZE	INLET PRESSURE (PSI)			
	100	200	300	400
-0010	3.1	4.4	5.4	6.3
-0015	4.7	6.6	8.1	9.4
-0020	6.2	8.8	10.6	12.4
-0025	7.7	10.9	13.3	15.4
-0030	9.1	12.9	15.8	18.2
-0035	10.5	14.8	18.1	20.9
-0040	11.8	16.7	20.4	
-0050	14.2	20.1		
-0060	16.4			
-0070	18.3			
-0080	19.9			

NOTE: Flow rates tabulated above include pressure drop through unit.

**DESCRIPTION**

SPECIFICATIONS FOR  
 AA190A-AIR MOTORIZED  
 ROTARY TANK WASHER

**Spraying Systems Co.**

Spray Nozzles and Accessories  
 North Avenue and Schmale Road  
 Wheaton, Illinois 60186

Ref : Data Sheet No.

Revision No. 190A-1

**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

**RECORD OF TELEPHONE CONVERSATION**

DATE 2-10-92

TIME 2:10 PM

PAGE 1 OF 1

FROM: <u>MYRON SCHULTZ</u>	TO: <u>JIM SLAUGHTER</u>
COMPANY: <u>UE &amp; C</u>	COMPANY: <u>BUTTERWORTH</u>
PHONE: <u>843-2454</u>	PHONE: <u>713-821-7300</u>
REFERENCE/PROJECT NO.: <u>6299.001 NREL</u>	
SUBJECT: <u>FERMENTATION/DIGESTION TANKS</u> <u>TANK C.I.P. SYSTEMS</u>	

TOPICS OF CONVERSATION:

- BUTTERWORTH DOES NOT DO SYSTEMS. THEY FURNISH THE CLEANING HEADS ONLY.
- THEY WILL SEND ME INFO ON THEIR CLEANING MACHINES.

DISTRIBUTION

FORM 62-20  
REVISED 5/81



**BUTTERWORTH®**

February 20, 1992

Mr. Myron Schultz  
United Engineering & Constructors  
P.O. Box 5888  
Denver, Colorado 80217

Dear Myron:

The ethanol pilot plant project sounds like an excellent opportunity for our tank cleaning machine product line.

Since being granted the first United States patent for a tank cleaning machine in 1925, Butterworth has been a leader in tank cleaning technology. Butterworth Tank Cleaning Machines manufactured in Houston, Texas, are sold and leased on a worldwide basis through a network of sales representatives and supply centers.

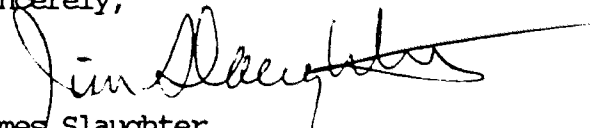
All Butterworth tank cleaning machines are designed to offer rugged and reliable service. They are powered by an internal turbine that is driven by the flow and pressure of the cleaning fluid. To meet individual tank cleaning requirements and flow of the cleaning fluid, the machines are available with various nozzle sizes and gearboxes.

The Butterworth Type LT stainless steel tank cleaning machine incorporates the latest design technology, resulting in rugged and reliable service. The major components of the unit are manufactured of Type 316 stainless steel that will meet the demands of most corrosive cleaning environments. The small, lightweight Butterworth Type LT produces a powerful cleaning action unrivaled by units many times its size.

The list price for a Type LT machine is \$2,495.00. Butterworth also carries a complete line of spare parts and tools for the machines.

I look forward to meeting you on my next trip to Denver, in the meantime, please give me a call with any questions you might have.

Sincerely,

  
James Slaughter  
Director of Sales

JS/jp

**Butterworth Tank Cleaning Machines, Inc.**  
**Butterworth Sales & Repairs, Inc.**

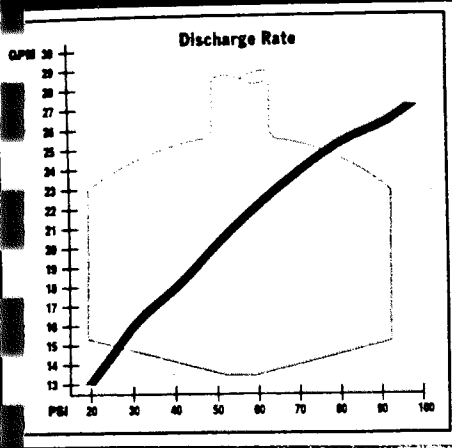
16737 W. Hardy St., Houston, Texas 77060

Phone: (713) 821-7300 Telex: (WU) 4620661 BUTTER FAX: (713) 821-5550

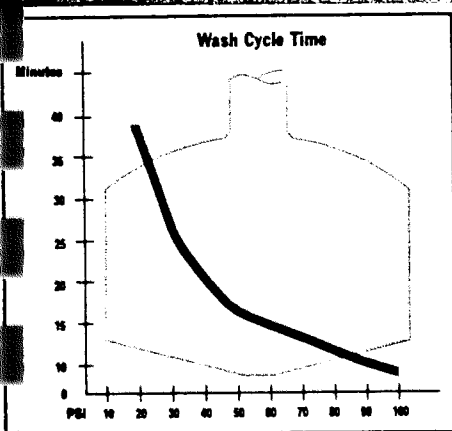


**BUTTERWORTH**

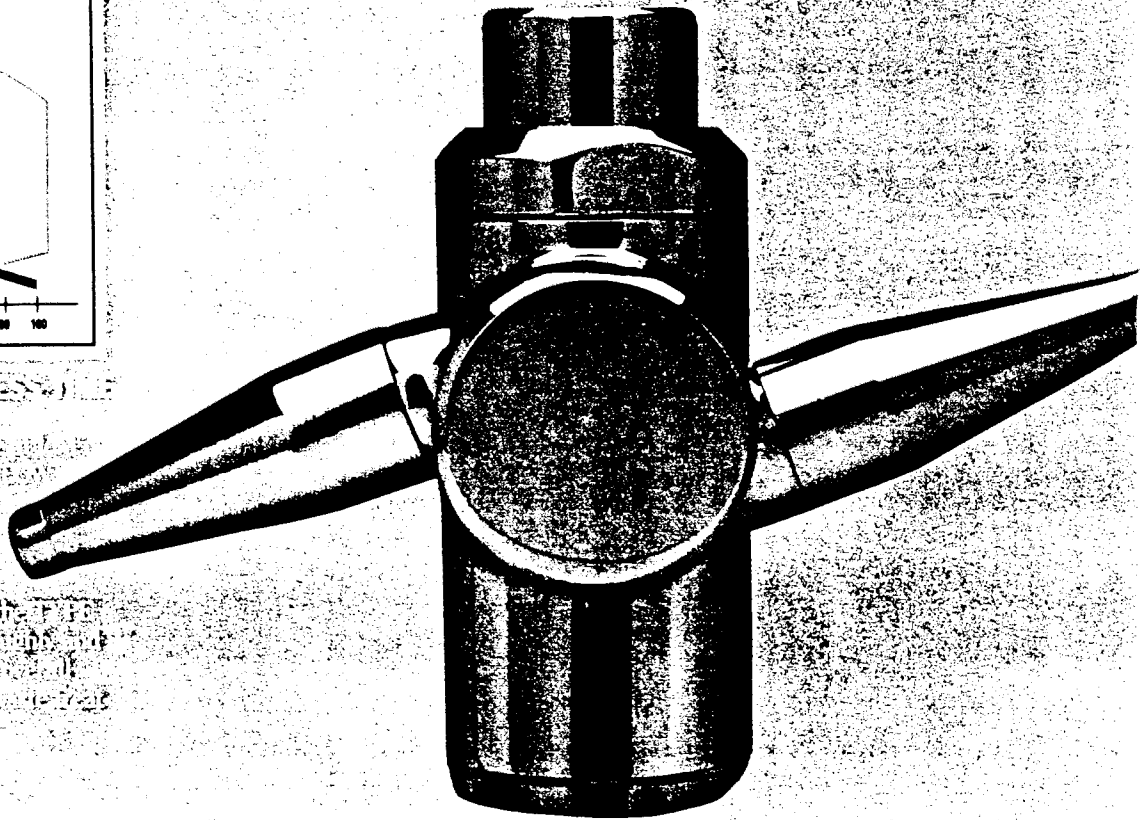
The original tank cleaning machine



**LESS EFFLUENT**



**LESS TIME**

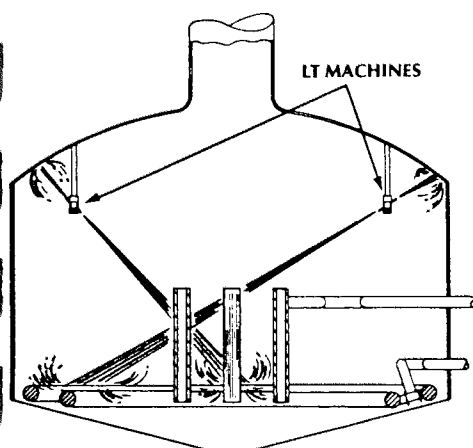


**TYPE 10000 TANK  
CLEANER**

## CLEAN-IN-PLACE OR PORTABLE CLEANING FOR ALL SIZE AND TYPES OF TANKS.

### TYPICAL INSTALLATIONS

With its sleek design and optional self-cleaning feature, the LT machine is ideally suited for clean-in-place applications in the beverage and food industries. The illustration below shows one type of installation in a large brewery kettle.



Two LT machines permanently installed in a brewery kettle.

Weighing only 15 pounds, BUTTERWORTH LT machines also make ideal portable cleaning units. For this, they may be mounted on a portable tripod and placed on the bottom of a tank, or simply lowered into a tank on the end of a fluid supply hose or pipe as shown in the tank truck cleaning illustration.

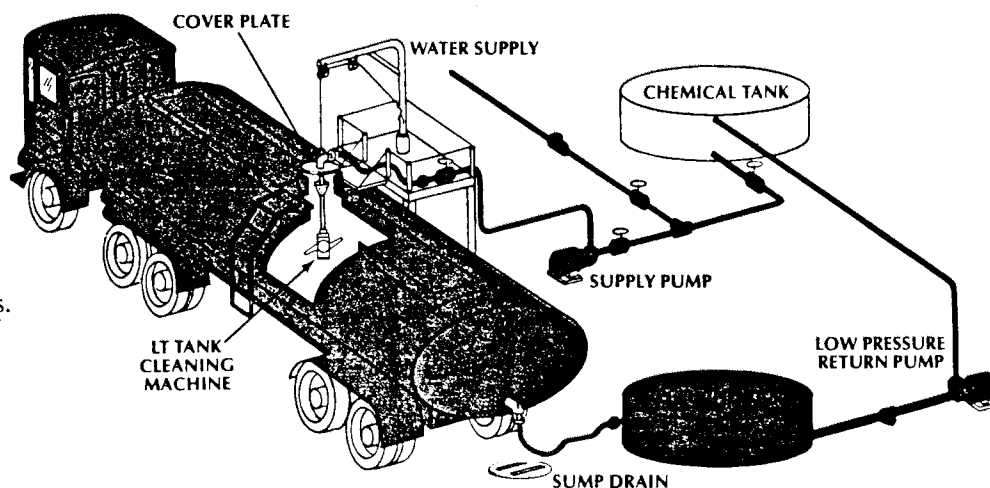
### TECHNICAL DATA:

**Weight:** 15 lbs (6.8 kg)

**Material Composition:** Major components are constructed of Type 316 stainless steel.

**Lubrication:** Sealed gear box with lubricants suitable to meet beverage and food industry standards.

**Machine Inlet Connection:** 1½ inch NPT with other sizes and adaptors available.



Tank truck cleaning station with fluid recirculation.

### TECHNICAL DATA (cont.)

**Power:** Internal turbine driven by cleaning fluid flow.

**Options:** Alternate gear ratios. Self-cleaning or standard (illustrated) nozzles in several sizes.

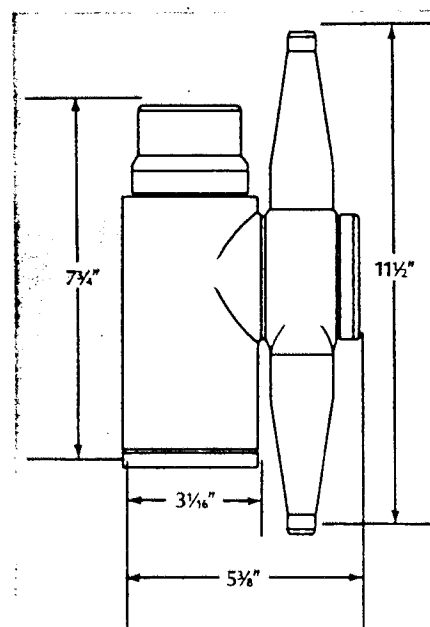
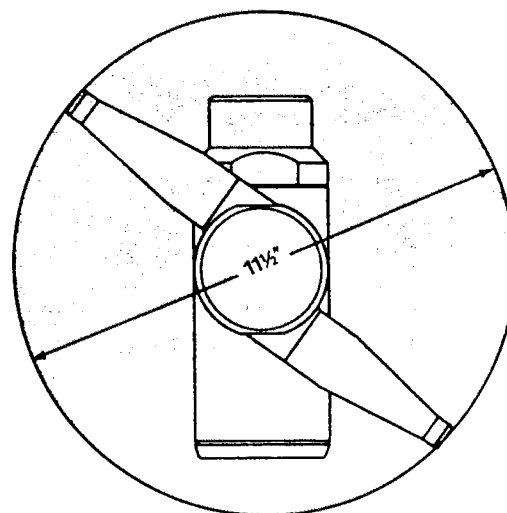
**Example:**

**Nozzle Aperture:** 10 mm.

**Fluid Pressure Range:** 50 to 200 psi (3.5 to 14.1 kg/cm²).

**Discharge Rate:** 40 to 100 gpm—U.S.A. (151 to 379 liters/min).

**Washing Cycle Time:** 8 to 20 minutes.



**BUTTERWORTH**

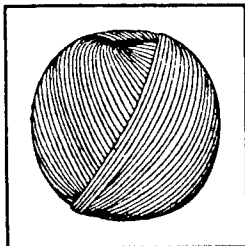
*The original tank cleaning machine*

16737 W. Hardy Street  
Houston, Texas 77060, USA  
Tel: (713) 821-7300  
FAX: (713) 821-5550  
Tlx: (ITT) 4620661 BUTTER

BUTTERWORTH is a registered trademark of Butterworth Tank Cleaning Machines, Inc.

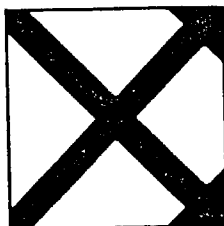
## PROGRAMMED CLEANING PATTERN GIVES COMPLETE COVERAGE.

The pattern traced by the jets on a tank's inner surface has been compared to the windings of a ball of twine... with successive traces crisscrossing and falling between previous traces. This produces a highly efficient programmed cleaning action.

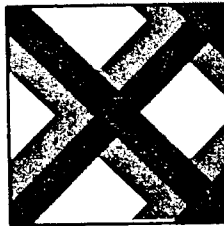


## FOUR WASH CYCLES FROM RINSE TO HEAVY WASH.

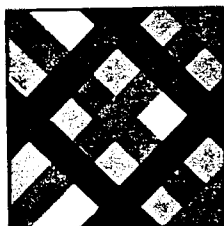
The LT machine completes four different wash cycles before repeating itself. One cycle completely covers the tank and each subsequent cycle increases the density of the wash pattern until all four cycles are completed. As shown by the typical wash patterns below, this provides four different washing densities: cycle one for lightest wash or a quick rinse; two for moderate wash; three for heavy wash; and four for heaviest wash.



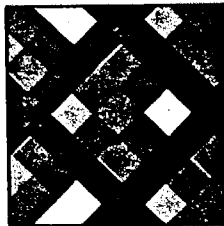
Light Wash



Moderate Wash



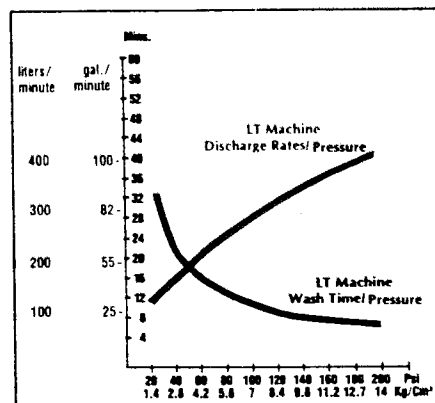
Heavy Wash



Heaviest Wash

## DISCHARGE RATES AND WASH TIMES TAILORED TO YOUR NEEDS.

The nozzle rotation and speed at which the body revolves are determined by the pressure of the cleaning fluid on the drive turbine. Adjust the pressure and an LT machine delivers the desired washing time or discharge rate. The graph shown below is for the standard LT machine with ten millimeter nozzles. Fluid pressures from 50 to 200 psi (3.5 to 14 kg/cm<sup>2</sup>) give a discharge range from 40 to 100 gpm (151 to 379 liters/min) with four-cycle wash programs varying from 8 to 20 minutes. Experience has shown that this wide range of performance characteristics handles most jobs. However, if required, LT machines are available with larger or smaller nozzles and gearing for faster or slower washing cycles.



### **PROVEN DESIGN.**

Like thousands of BUTTERWORTH® tank cleaning machines now in use, the Type LT machine uses concentrated jets of water or other solutions to clean an entire tank interior with mechanical precision. The nozzles and the machine rotate about two perpendicular axes to produce a cleaning pattern that crisscrosses and overlaps for complete coverage. The end result is a cleaner tank with less time lost from production.

### **RELIABLE AND EASILY MAINTAINED.**

The LT machine has been designed for reliability and ease of maintenance. It has a minimum of moving parts and utilizes advanced materials. Major components are constructed of Type 316 stainless steel. This permits the use of virtually all types of hot or cold cleaning fluids, water or chemicals, to facilitate the toughest cleaning jobs. It is easily disassembled for routine maintenance or repair.

### **OUTPERFORMS COMPETITION.**

Although the LT machine is small and lightweight (15 pounds), it has all the proven performance of the larger BUTTERWORTH tank cleaning machines ... and more.

Used as a clean-in-place or portable unit, a single LT machine does a better job than several sprayballs ... cleaning faster and more efficiently without vaporizing cleaning fluids.

**Specially designed for  
beverage, food, and  
chemical industries.**

**Easily handles  
the toughest job.**

**Outperforms  
other machines.**

**Reliable and  
easily maintained.**

**Reduces  
cleaning time.**

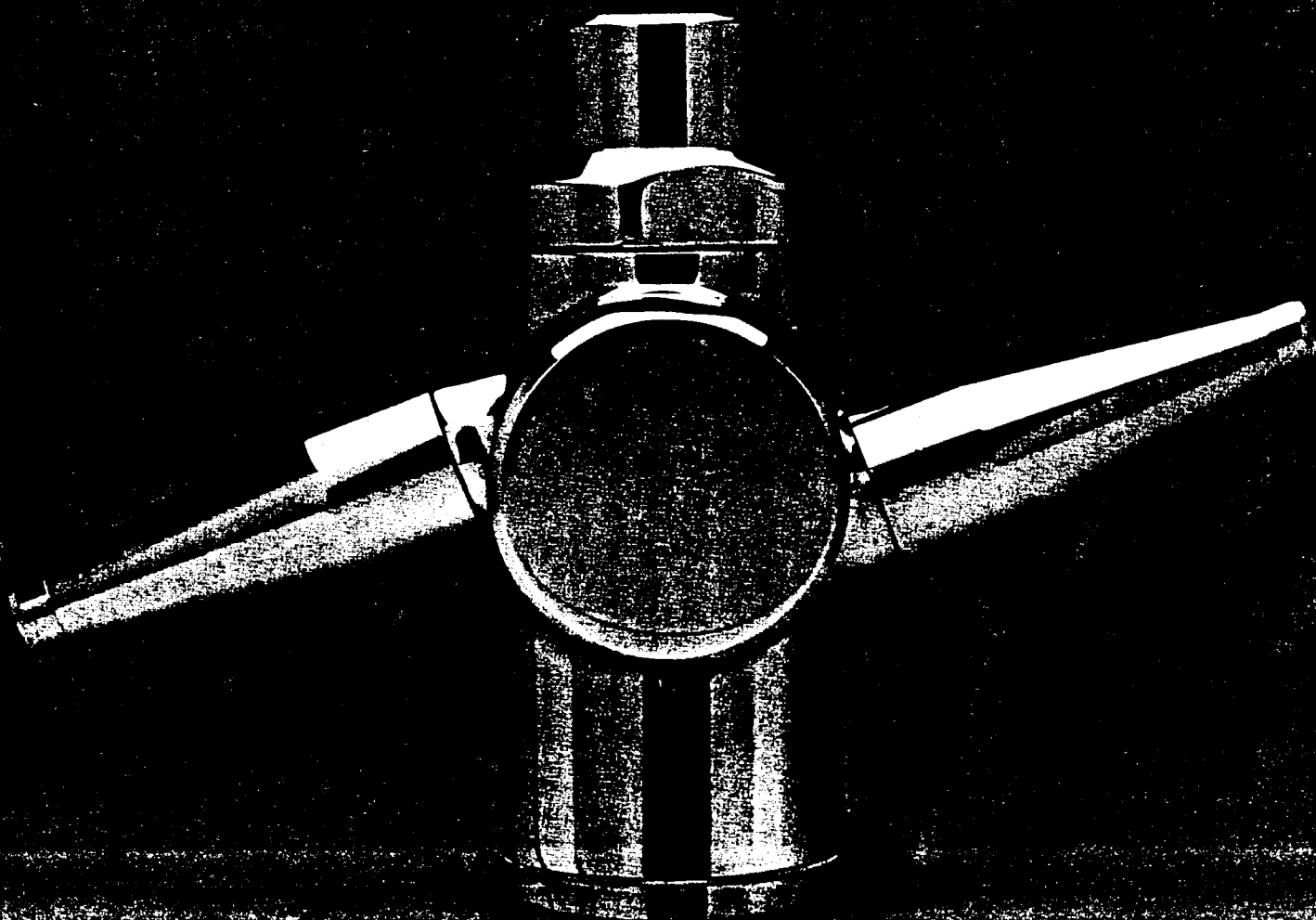




**BUTTERWORTH**

*The original tank cleaning machine*

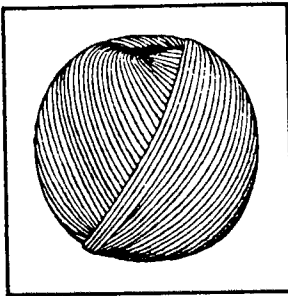
# TYPE LT Tank Cleaning Machine



# LOW FLOW

## A PROVEN DESIGN FOR LOW PRESSURE USE

The Butterworth® TYPE LT LOW FLOW is a fluid-driven twin nozzle tank cleaning machine. Washing fluid supplied by an external pump drives an internal turbine. The turbine transmits power to gears which rotate both the body of the machine and the nozzles about two perpendicular axes. The wash fluid exiting from the nozzles produces a cleaning pattern which criss-crosses and overlaps for the complete cleaning of a tank interior.



## SPECIALLY DESIGNED FOR THE CHEMICAL, BEVERAGE AND FOOD INDUSTRIES

All major components of the Butterworth TYPE LT LOW FLOW are manufactured of 316 Stainless Steel.

Using concentrated jets of water or other solutions to clean an entire tank interior with mechanical precision, a single TYPE LT LOW FLOW machine delivers faster and more efficient cleaning than several sprayballs without vaporizing fluids.

## HANDLES THE TOUGHEST JOBS

A four-part wash cycle — from rinse to heavy wash — comprises the highly efficient programmed cleaning action of the TYPE LT LOW FLOW.

Manufactured from 316 Stainless Steel, the Butterworth® TYPE LT LOW FLOW allows use of virtually all types of hot or cold cleaning fluids, water, or chemicals to meet the demands of the toughest cleaning jobs.

Reliable and easily maintained, the TYPE LT LOW FLOW has few moving parts and can be easily disassembled for routine maintenance and repair.

## TECHNICAL DATA

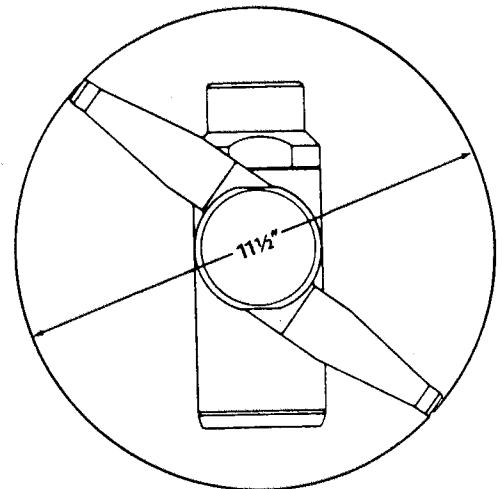
**Weight:** 15 lbs (6.8 kg).

**Material Composition:** Major components are constructed of Type 316 stainless steel.

**Lubrication:** Sealed gear box with lubricants suitable to meet beverage and food industry standards.

**Machine Inlet Connection:** 1-1/2 inch NPT with other sizes and adaptors available.

**Power:** Internal turbine driven by cleaning fluid flow.



**Options:** Alternate gear ratios. Self-cleaning or standard (illustrated) nozzles in several sizes.

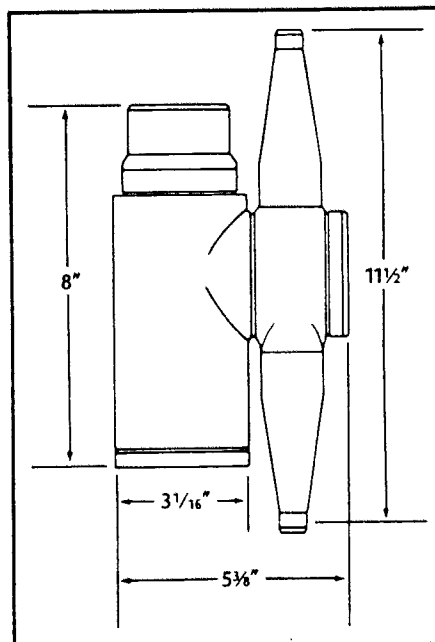
**Example:**

**Nozzle Aperture:** 6mm.

**Fluid Pressure Range:** 20 to 100 psi (1.4 to 7.0 kg/cm<sup>2</sup>).

**Discharge Rate:** 13 to 27 gpm - U.S.A. (49 to 102 liters/min).

**Washing Cycle Time:** 10 to 39 minutes.



# BUTTERWORTH®

The original tank cleaning machine

16737 W. Hardy Street  
Houston, Texas 77060, USA  
Tel: (713) 821-7300  
FAX: (713) 821-5550  
Tlx: (ITT) 4620661 BUTTER

BUTTERWORTH is a registered trademark of Butterworth Tank Cleaning Machines, Inc.

CHARACTERISTICS OF BUTTERWORTH TYPE LT STAINLESS STEEL TANK CLEANING MACHINES

MODEL NO.	Pressure, PSIG	30	40	50	75	100	125	150	175
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LT6:Z:M:3:N:0	Flow Rate, USGPM	16	18	20	24	27	32	N/A	N/A
	Cycle Time, minutes	26	21	17	12	10	9	N/A	N/A
	Cleaning Radius, ft.	7	8	9	12	15	16	N/A	N/A

LT8:Z:3:1:N:0	Flow Rate, USGPM	N/A	N/A	32	40	47	54	58	63
	Cycle Time, minutes	N/A	N/A	13	11	9	8	7	6
	Cleaning Radius, ft.	N/A	N/A	11	17	21	25	27	34

LT10:Z:2:1:N:0	Flow Rate, USGPM	N/A	N/A	45	60	75	85	94	98
	Cycle Time, minutes	N/A	N/A	20	15	12	10	10	9
	Cleaning Radius, ft.	N/A	N/A	12	18	22	26	30	40

LT12:Z:2:1:N:0	Flow Rate, USGPM	N/A	N/A	70	90	105	118	125	130
	Cycle Time, minutes	N/A	N/A	42	32	27	22	20	18
	Cleaning Radius, ft.	N/A	N/A	14	20	24	28	33	43

# GAMAJET TANK WASHING MACHINES

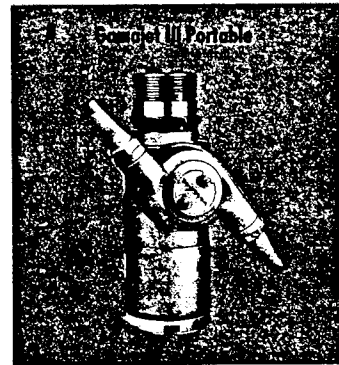
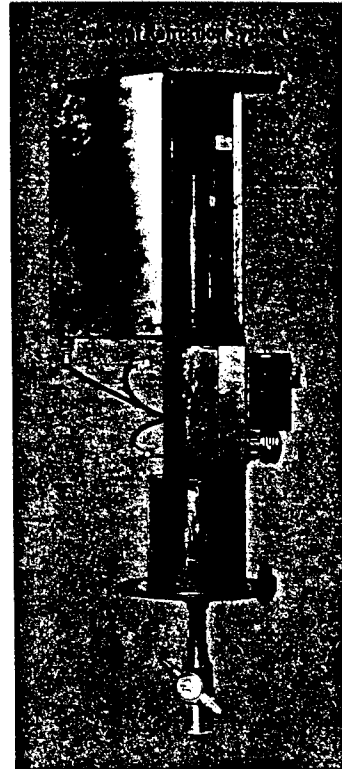


The New Gamajet IV Strip Nozzle  
with 100% stainless steel construction

## The Smart Way to Keep Your Tanks Clean

# The Gamajet Family of Products

## A machine that's right for every tank cleaning job



Only Gamajet delivers the breadth and depth of field-tested engineering, application, installation and service experience to offer a fully integrated systems approach to today's complex tank washing challenges. Only Gamajet offers you more than a machine... by providing the total support you need for reliable, efficient, economical tank washing. That's why, still nothing cleans like Gamajet.

U.S. West Coast:  
**1-800-BUY-JETS**  
**(289-5387)**



**SYBRON | Gamajet®**

*the exclusive manufacturer/marketer of Gamajet tank washing machines*

U.S. East Coast:  
**1-800-678-0020**

Manufacturing & Sales Headquarters: 21066 Alexander Court, Hayward, CA 94545 U.S.A. Phone: (415) 293-9040 Fax: (415) 293-9045

## ***Still, Nothing Cleans Like Gamajet***

Sybron Chemicals Inc. Corporate Headquarters: Birmingham, New Jersey 08011 U.S.A.

Technical sales and service in principal ports and cities around the world

The information contained in this bulletin is to the best of our knowledge accurate, but since the circumstances and conditions to which it may be used are beyond our control we do not accept liability for any loss or damage that may occur nor do we offer any warranty of immunity against patent infringement.

# Introducing the new Gamajet IV

## Proven performance plus 15% greater cleaning efficiency

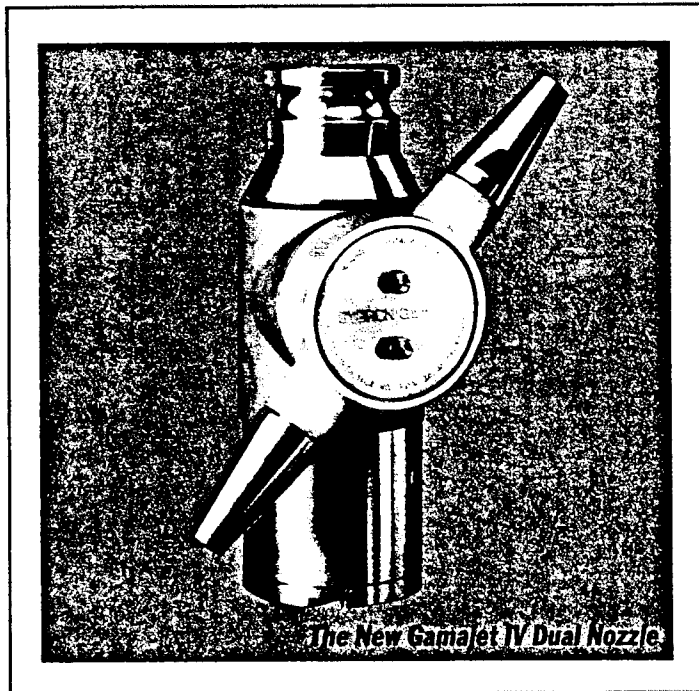
Rugged construction. Precise engineering. Reliable performance. And experienced, responsive, world-wide service.

For over 30 years, these leadership traits have made Gamajet tank washing machines the first choice among the world's largest breweries, chemical tanker fleets, food and chemical processors, or anyone who has specialized needs for frequent, efficient machine cleaning of their tanks, vats, or vessels... large or small.

Since the beginning, when they were originally designed to operate in the holds of ships far from service facilities, Gamajet machines have always had a reputation for rugged dependability — and ease of service away from port. We have carried this tradition of reliability into all our machines for use in any application on land or at sea.

**Today, Gamajet continues to lead the market with the newest member of its family — the Gamajet IV.**

The new Gamajet IV delivers at least 15% improved tank washing efficiency over our proven Gamajet III model. This means increased jet scrubbing



power for faster cleaning cycles that will save on operating costs day-after-day, year-after-year.

Driven hydraulically by a new turbine and gear system, the Gamajet IV revolves 360° in both horizontal and vertical planes, with rotary dual or triple nozzles providing full 360° or half 180° washing coverage to clean tank interiors or bottoms.

### Benefits of the new Gamajet IV:

■ New design and construction features have made the Gamajet IV require *even less* frequency of service or repair than our earlier, trouble-free models.

■ Less frequency of service and repair means less downtime, even at short wash cycles (5 minutes or less), low volumes (30+gpm),

and high pressures (up to 700 psi).

■ Simplicity of design, rugged construction, and readily available spare parts (guaranteed 24-48 hour delivery in the continental U.S.) *eliminate* the need for factory servicing, thereby keeping your systems serviced and running on-site.

■ The fast, easy interchange of dual or triple washing heads, nozzles, and turbines offer complete flexibility in one machine. The Gamajet IV gives you a choice of flow rates, pressures, wash cycle times, and jet indexing patterns — 12 nozzle sizes, 7 turbine combinations, 2 gear ratios, and dual or triple nozzle configurations.

■ Parts are easily interchanged on-site to adapt to any tank cleaning job...from a light rinse, to a medium wash, to a heavy scrubbing.

■ By on-site matching of the Gamajet IV configuration to your specific washing job, you enjoy greater operating economy, utilizing the optimally efficient combination of water, chemicals, and energy.



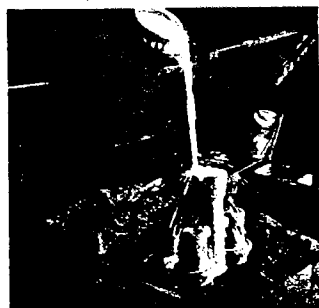
**SYBRON | Gamajet®**

# Our New Plant Gives You Unbeatable Service



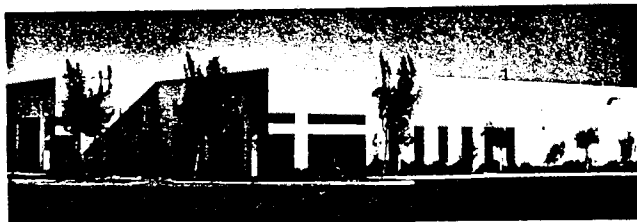
## Engineering and design

—Gamajet scientists and engineers are constantly in touch with our customers all over the world, researching and testing new product concepts to maintain our leadership position in the industry. Product refinement and trouble-free design are on-going activities at Gamajet.



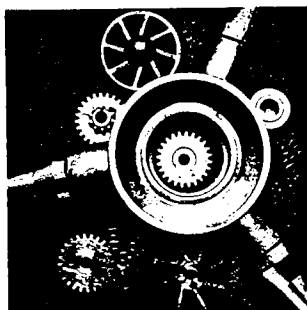
## Foundry and machine shop

—Gamajet's manufacturing facilities insure consistent product quality control and adherence to our own high design standards and specifications.



As the exclusive manufacturer/marketer of Gamajet tank cleaning machines and systems, we are part of a worldwide company involved in all aspects of environmental protection and waste water management. We are backed by the global resources of Sybron Chemicals Inc., with corporate headquarters in Birmingham, New Jersey.

Our new west coast Gamajet technical sales and manufacturing plant, conveniently located in the San Francisco Bay Area, offers a modern facility to provide a total systems approach to every tank cleaning need.



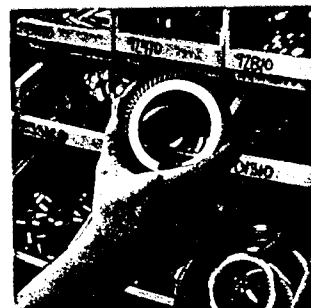
**Sonic cleaning for purity**—This specialized cleaning process of all Gamajet parts from the foundry insures product purity in your plant.



**Assembly**—Trained technicians assemble each Gamajet, with a special eye to detail.



**Testing, inspection, and quality control**—Each Gamajet tank washing machine undergoes rigorous testing prior to shipping to a customer for field use.



## Complete inventory of products and parts—

Including the well-proven Gamajet III and the exciting new Gamajet IV. Guaranteed 24-48 hour delivery within the continental U.S.



**Technical field support/trouble-shooting**—At Gamajet, our technical people work directly with you...on-call 24 hours a day to assist you with any questions or technical challenges you may face.



**Shipping/customer service**—Our experienced staff understands your need for prompt, responsive service.

# Improved Features of the Gamajet IV

Gamajet IV's tungsten carbide bearings, teflon lip seals, and PTFE/ETFE gear box bushings provide greater corrosion resistance and longer wear life than other machines, which often use oil-ite bronze bearings/bushings and nitrile/viton O-ring seals. Thanks to tungsten carbide bearings, the rotor shaft always stays round and true.

Gamajet IV features a high reduction ratio spur gear system with new, improved design and construction for stronger torque drive and longer wear life, for both portable type sealed lubricated or fixed CIP Flo-Thru oilless gearbox models.

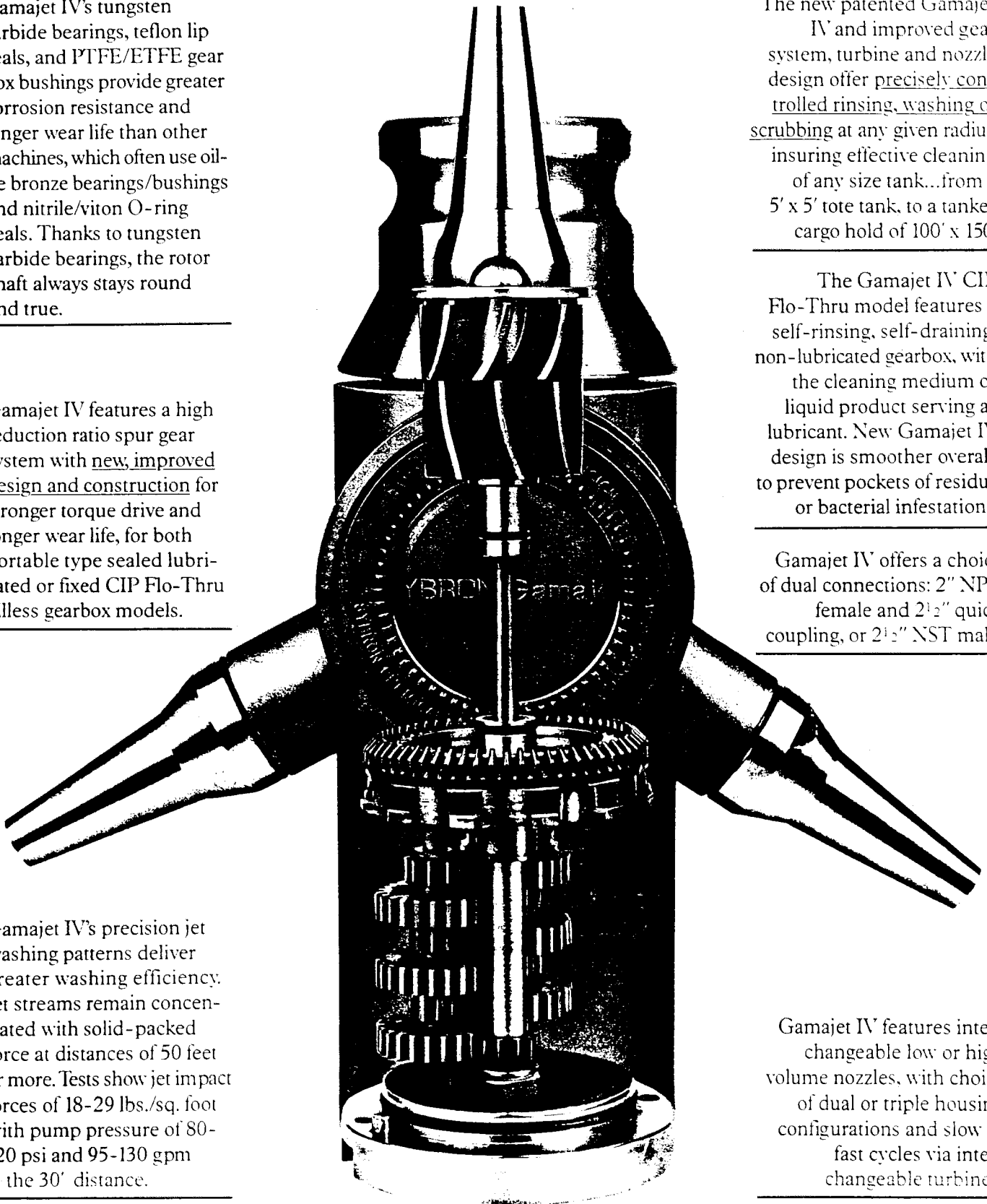
Gamajet IV's precision jet washing patterns deliver greater washing efficiency. Jet streams remain concentrated with solid-packed force at distances of 50 feet or more. Tests show jet impact forces of 18-29 lbs./sq. foot with pump pressure of 80-120 psi and 95-130 gpm at the 30' distance.

The new patented Gamajet IV and improved gear system, turbine and nozzle design offer precisely controlled rinsing, washing or scrubbing at any given radius, insuring effective cleaning of any size tank...from a 5' x 5' tote tank, to a tanker cargo hold of 100' x 150'.

The Gamajet IV CIP Flo-Thru model features a self-rinsing, self-draining, non-lubricated gearbox, with the cleaning medium or liquid product serving as lubricant. New Gamajet IV design is smoother overall, to prevent pockets of residue or bacterial infestations.

Gamajet IV offers a choice of dual connections: 2" NPT female and 2 1/2" quick coupling, or 2 1/2" NST male.

Gamajet IV features interchangeable low or high volume nozzles, with choice of dual or triple housing configurations and slow or fast cycles via interchangeable turbines.



# Introducing the new Gamajet IV

## Proven performance plus 15% greater cleaning efficiency

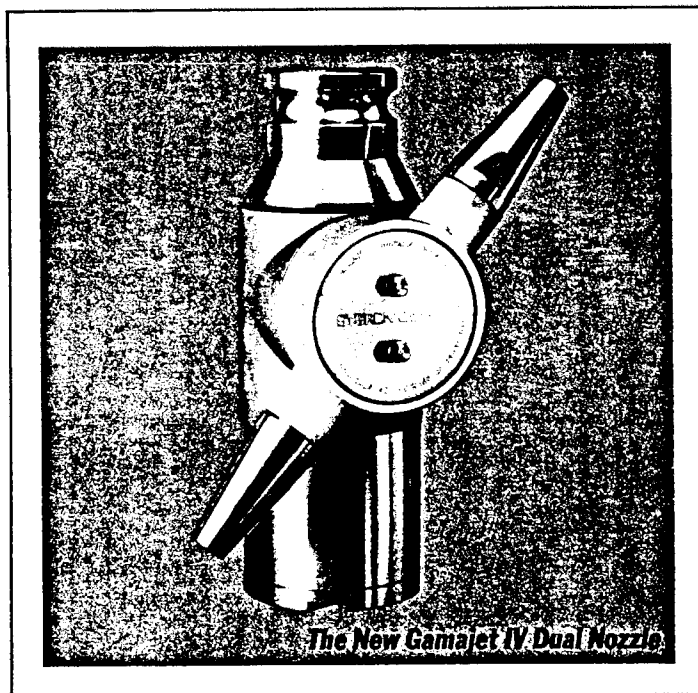
Rugged construction. Precise engineering. Reliable performance. And experienced, responsive, world-wide service.

For over 30 years, these leadership traits have made Gamajet tank washing machines the first choice among the world's largest breweries, chemical tanker fleets, food and chemical processors, or anyone who has specialized needs for frequent, efficient machine cleaning of their tanks, vats, or vessels...large or small.

Since the beginning, when they were originally designed to operate in the holds of ships far from service facilities, Gamajet machines have always had a reputation for rugged dependability—and ease of service away from port. We have carried this tradition of reliability into all our machines for use in any application on land or at sea.

**Today, Gamajet continues to lead the market with the newest member of its family—the Gamajet IV.**

The new Gamajet IV delivers at least 15% improved tank washing efficiency over our proven Gamajet III model. This means increased jet scrubbing



power for faster cleaning cycles that will save on operating costs day-after-day, year-after-year.

Driven hydraulically by a new turbine and gear system, the Gamajet IV revolves 360° in both horizontal and vertical planes, with rotary dual or triple nozzles providing full 360° or half 180° washing coverage to clean tank interiors or bottoms.

### Benefits of the new Gamajet IV:

■ New design and construction features have made the Gamajet IV require *even less* frequency of service or repair than our earlier, trouble-free models.

■ Less frequency of service and repair means less downtime, even at short wash cycles (5 minutes or less), low volumes (30+gpm),

and high pressures (up to 700 psi).

■ Simplicity of design, rugged construction, and readily available spare parts (guaranteed 24-48 hour delivery in the continental U.S.) *eliminate* the need for factory servicing, thereby keeping your systems serviced and running on-site.

■ The fast, easy interchange of dual or triple washing heads, nozzles, and turbines offer complete flexibility in one machine. The Gamajet IV gives you a choice of flow rates, pressures, wash cycle times, and jet indexing patterns—12 nozzle sizes, 7 turbine combinations, 2 gear ratios, and dual or triple nozzle configurations.

■ Parts are easily interchanged on-site to adapt to any tank cleaning job...from a light rinse, to a medium wash, to a heavy scrubbing.

■ By on-site matching of the Gamajet IV configuration to your specific washing job, you enjoy greater operating economy, utilizing the optimally efficient combination of water, chemicals, and energy.



**SYBRON | Gamajet®**

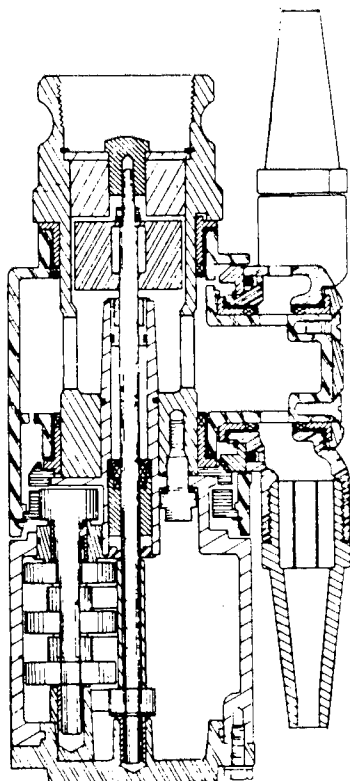
**SYBRON CHEMICALS INC. / 21066 ALEXANDER CT. / HAYWARD, CA 94545 / (415) 293-9040 / (800) BUY-JETS (289-5387) / TELEX 34-9479 / TELEFAX (415) 293-9045**

# **CORROSION RESISTANCE OF GAMAJET IV BRONZE & STAINLESS MODELS**

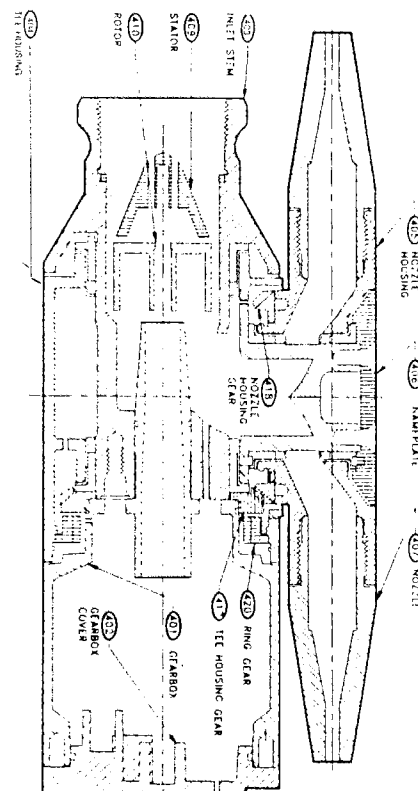
(A—Satisfactory—100% warranty; B—Useful Resistance—75% warranty;  
C—Limited Use—50%; X—Not recommended—No warranty)

CORROSIVE PRODUCT	% — ° F	SILICON BRONZE	TYPE 316 STAINLESS
HYDROCHLORIC ACID HYDROGEN CHLORIDE	< 1%, 70°	C	C
	< .5%, 175°	C	C
	> 2-20%, 70° +	X	X
HYDROFLUORIC ACID	< 10%, 77°	B	C
	> 10%, 50-70°	B	X
	< 20%, 70	B	X
	> 20%, 50° +	C	X
FERRIC CHLORIDE	< 5%,	C	B
	> 10%, 70°	X	C
MAGNESIUM HYDROXIDE	< 3%, 70°	A	A
	< 10%, 212°	A	A
	> 10%, 212°	B	B
SODIUM HYDROXIDE	< 5%, 70°	B	A
	> 5%, 100° +	C	A
SODIUM HYPOCHLORITE		C	B
CREOSOTE	190°	A	A
NITRIC ACID	< 20%, 77° +	X	B
	> 20%, 77° +	X	C
PHOSPHORIC ACID	< 3%, 70°	C	A
	> 3%, 70° +	C	B
SULFURIC ACID	< 2%, 70°	C	A
	> 2%, 70° +	X	B

#### GAMAJET III



#### GAMAJET IV



\* PATENTED WORLDWIDE  
ALL PARTS INTERCHANGEABLE EXCEPT THE NAMEPLATE

#### COMPARATIVE CLEANING EFFICIENCY

(As Measured in Pounds/Sq. Ft. Jet Impact Force on a 12" Dia. Target)

Jet Distance	Nozzle Size 3-N	80 PSI #/sq.ft.		100 PSI #/sq.ft.		120 PSI #/sq.ft.		Average Variance IV vs. III Models
		III	IV	III	IV	III	IV	
10 Feet- 20' Dia. Tank	5/16"	15.3	16.8	18.3	20.8	21.3	23.4	10.9%+
	3/8"	21.4	22.9	26.0	27.5	32.1	34.0	5.6%+
	5/8"	51.0	53.9	56.3	58.6	61.5	65.0	5.2%+
20 Feet 40' Dia. Tank	5/16"	9.2	10.7	10.2	13.8	16.8	18.3	19.2%+
	3/8"	20.0	20.6	22.9	26.0	26.0	30.1	11.3%+
	5/8"	38.9	42.8	46.9	47.4	51.9	53.9	4.6%+
30 Feet 60' Dia. Tank	5/16"	3.1	4.6	9.2	11.0	14.1	15.3	17.0%+
	3/8"	10.7	18.3	15.3	24.5	19.6	29.3	58.0%+
	5/8"	29.0	30.6	38.2	39.5	44.6	45.1	2.9%+

NOTE: Gamajet III and the new Gamajet IV models were tested under the same conditions of input pressure and volume. Above test figures are adjusted to represent actual target of 12" or .785 sq. ft., using a Cole-Palmer Gauge Cell.

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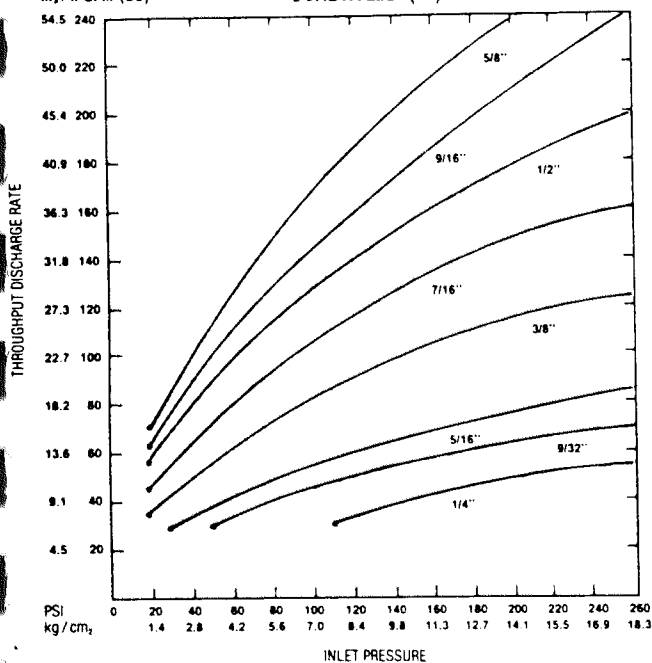
The information contained in this bulletin is to the best of our knowledge accurate; but since the circumstances and conditions under which it may be used are beyond our control we do not accept liability for any loss or damage that may occur nor do we offer any warranty of immunity against patent infringement.

#### GAMAJET EQUIPMENT DIVISION

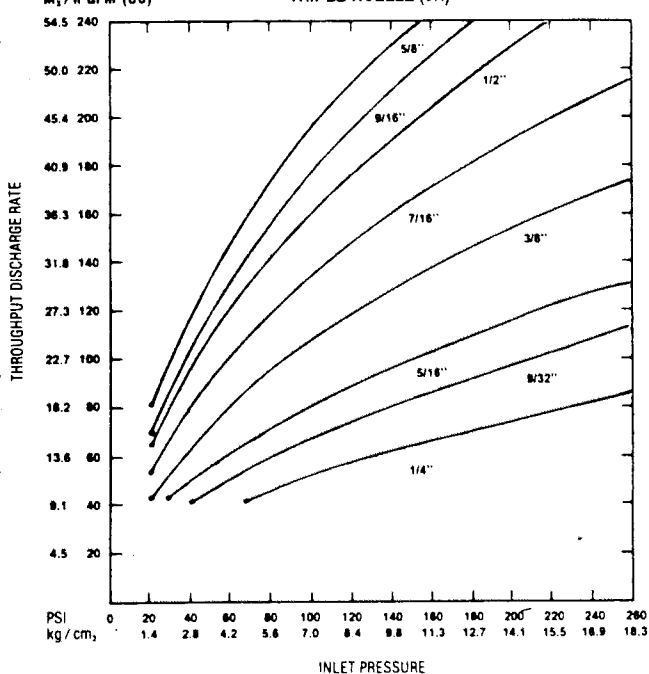
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# GAMAJET... Performance Characteristics

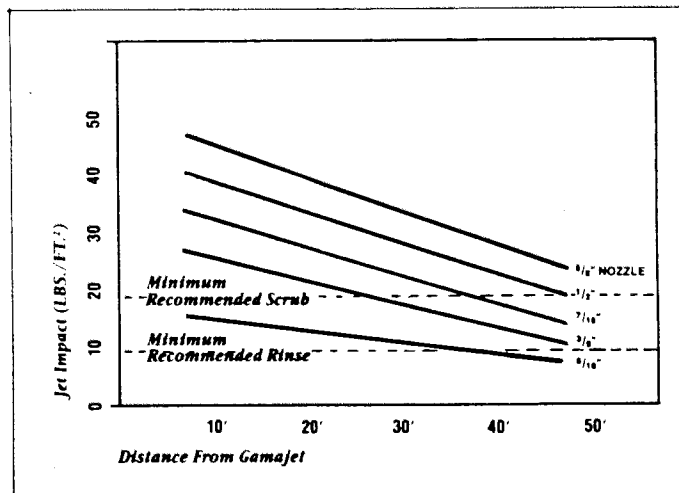
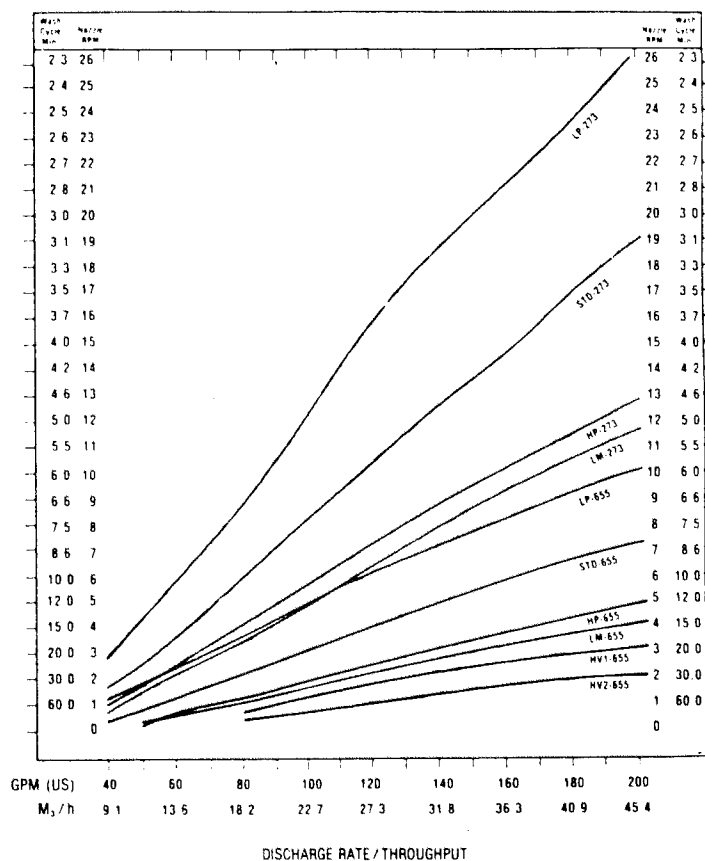
Gamajet IV — Throughput / discharge rate vs. nozzle size & pressure  
DUAL NOZZLE (2N)



Gamajet IV — Throughput / discharge rate vs. nozzle size & pressure  
TRIPLE NOZZLE (3N)



GAMAJET IV  
Nozzle RPM / Wash Cycle Time vs  
Discharge Rate & Turbine/Gearbox Ratio

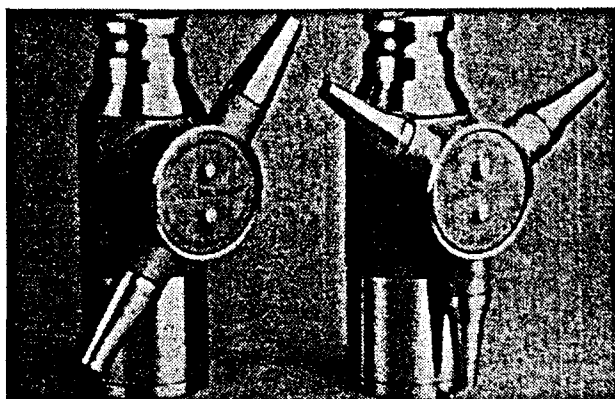


JET IMPACT FORCE AT TYPICAL 100 PSI / 7 Kg. cm²

## NOTE:

Throughput graphs are based on standard machines with standard turbines. Installation of optionally available turbines (LP, LM, HP, or HV) can affect throughput figures up to  $\pm 5\%$ . Throughputs for CIP models with external self-cleaning nozzle will be higher by approximately 5 gpm at 100 psi and 7 gpm at 200 psi.

Cycle times are based on standard gearbox lubricant (SAE 140) at 100° F. If lubricant of different viscosity is used, cycle times will be affected accordingly.



#### TECHNICAL SPECIFICATIONS

#### DESCRIPTION:

Developed and upgraded from the proven Gamajet III. Hydraulically driven rotary tank cleaning machine revolves 360° in both horizontal and vertical planes with synchronized solid jets providing a tight and thorough scouring pattern covering all interior tank surfaces in one complete cycle. A choice of twelve nozzle sizes and hydraulic turbines, including two gear systems, offer a wide operating range of flow rates, nozzle rotation speeds, and wash cycles. Capable of high concentration chemical recirculation cleaning or high pressure-low volume water blasting in fixed CIP automated systems.

#### OPERATING RANGE:

Pressure:	40 to 500 psi (2.8 to 34.5 bar) for standard model 40 to 700+ psi (48.3 bar) for high pressure model
Temperature:	-60° to 250°F. (-29° to 121°C.)
Flow Rate:	30 to 220 gpm (7 to 50 tons/hr) for standard model
Wash Cycle Time:	3 to 30 minutes
Nozzle Rotation Speed:	2 to 20 rpm

#### OVERALL DIMENSIONS:

Height:	12.2 in. (31.0 cm.)
Diameter:	4.2 in. (10.7 cm.)
Width:	6.0 in. (15.2 cm.) including nozzle housing

#### MINIMUM ENTRY OPENING:

Pin Drive:	Dual: 12.6 in. (32.0 cm.)	Triple: 11.4 in. (29.0 cm.)
Optional Clutch Drive:	Dual: 6.6 in. (16.8 cm.)	Triple: 9.6 in. (24.4 cm.)

#### WEIGHT:

Dual: 26 lb. (11.8 kg.)	Triple: 27 lb. (12.3 kg.)
-------------------------	---------------------------

#### DUAL INLET CONNECTION:

Standard:	2 in. NPT female and 2½ in. quick disconnect male
Optional:	2 in. NPT female and 2½ in. NST (NH) hose thread male

#### CONSTRUCTION/DESIGN:

##### New Features:

Streamlined turbine and internal flow passages, including a patented porting design that significantly improves efficiency.

##### Castings:

Investment cast parts of type 316 stainless steel insure consistent strength and quality for higher pressure ratings.

- Shafts:** Rotor shaft and gearbox shafts are made of hardened stainless steel. For increased wear resistance in specific applications, the rotor shaft is supplied with a plasma-sprayed ceramic or other protective coating. The rotor shaft is also fitted with a polished carbide thrust washer for added durability.
- Bearings, Shaft:** Rotor shaft bearings are tungsten carbide. Gearbox shaft bearings in flo-thru (oilless) gearboxes are PTFE or other nonmetallic materials. Standard bearings in oil-lubricated gearboxes are Oilite bronze with nonmetallic bearings available as an option.
- Bearings, Waterside:** Tee and nozzle housing bearings are made of carbon fiber reinforced polyphenylene sulfide with PTFE added as a lubricant. Nozzle housing bearings are now pin-located for positive indexing and ease of assembly.
- Bearing Cups:** Main body castings are protected against wear by replaceable stainless steel cups installed at all bearing locations.
- Seals, Dynamic:** Rotary shaft and housing seals are spring-loaded reinforced PTFE for extra long wear and protection against leakage, abrasion damage, and deposit build-up.
- Seals, Static:** O-ring materials are selected for each application. Available materials include fluorocarbon, nitrile, chloroprene, Kalrez® and EPDM. Others can be supplied on order.
- Drive Gears:** A new gear system of improved design and construction is incorporated in Gamajet IV models for increased wear life. All gears are manufactured entirely of selected stainless steel alloys and the two bottom gears are fitted with long-life tungsten carbide thrust washers. Gear bushings compounded of PTFE or ETFE are standard in flo-thru oilless gearboxes and are optional in sealed lubricated gearboxes where Oilite bronze is standard.
- Lubrication, Gearbox:**
- Sealed:** Oil-lubricated machines have a sealed gearbox filled with FDA approved oil. Any heavy duty gear oil, high or low temperature lubricant or grease may be used.
- Flo-thru:** The flo-thru gearbox is lubricated by the cleaning solution. With this option maintenance of gearbox seals is eliminated.
- Lubrication, Waterside:** A controlled amount of the cleaning solution is permitted to flow through the tee and nozzle housing bearings for lubrication and cooling. This flow also aids in removing solid particles from between the bearings and cups to minimize abrasion damage to these parts.
- Self-Cleaning Provisions:** In all Gamajet models, a low-pressure bypass system keeps the bevel gears and other internal parts flushed free of debris that could interfere with proper functioning.
- Self-cleaning CIP models are additionally equipped with the following:
1. A small auxiliary nozzle which washes the exterior of the machine.
  2. Internal passages to provide direct high-pressure rinsing of any areas where build-up of deposits could allow bacterial growth.
  3. Holes to allow complete drainage of any cleaning solution remaining in the machine at the end of the cleaning cycle that could cause product contamination. The gearbox of the flo-thru model also drains completely when the machine is not in use.
- Nozzles:** Redesigned dual and triple nozzle housings with centerline nozzle mounting on the Gamajet IV eliminate unbalanced reaction forces. Interchangeable nozzles are now available in twelve sizes from 5/8 in. (15.9 mm.) down to .177 in. (4.5 mm.). Nozzle sizes of 1/4 in. and smaller are offered with new tungsten carbide inserts for improved jet performance at high pressures.

#### **OPERATING & MAINTENANCE:**

Complete operating and maintenance procedures are covered in a detailed instruction manual furnished with all machines. Ready availability of spare parts or kits and ease of maintenance on-site minimizes or eliminates the need for factory repairs.

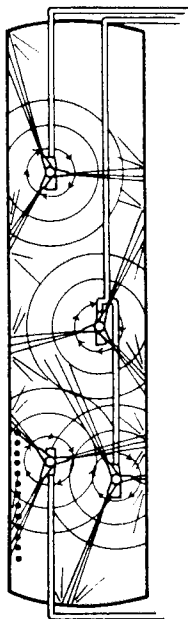
Prompt factory overhaul or repair service is always available at Hayward, California. Replacement parts are stocked year round. Special 24-48 hour delivery upon request at no extra charge.

#### **WARRANTY:**

Stainless steel Gamajets are warranted for two years from date of shipment against any defects in workmanship or materials. Normal maintenance parts such as O-rings, bearings, seals, etc. are not included under this warranty, nor is damage caused by dropping, use of destructively corrosive fluids, or other abuse. This warranty shall not apply to any malfunction resulting from use of non-Gamajet replacement parts purchased from any source other than Sybron/Gamajet or an authorized Sybron/Gamajet distributor.

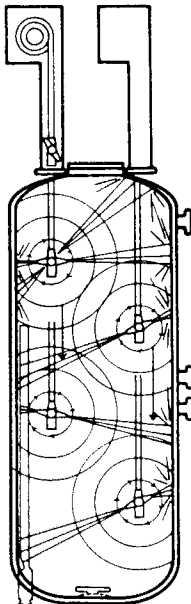
# Special Applications

**Fermentation**



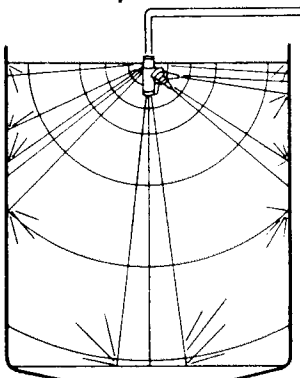
**Triple Nozzle 360°**

**Chemical Reactor**



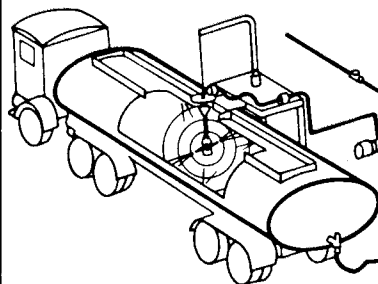
**Dual Nozzle 360°**

**Open Vat**



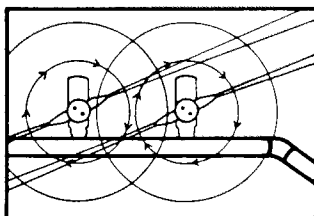
**Directional 180°**

**Tank Truck/Rail Car**

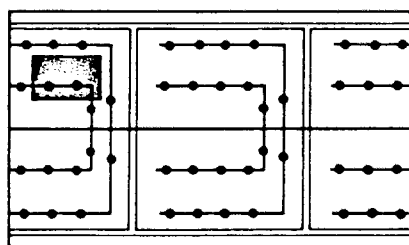


**Dual Nozzle 360°**

**Marine Tanker**



**Gamajet Cleaning Pattern**



**Dual Nozzle High-Capacity Multiple Units 360°**

## Gamajet IV Technical Specifications

### OPERATING RANGE:

Pressure	40 to 500 psi (2.8 to 34.5 bar) for standard model
	40 to 7000 psi (2.8 to 483 bar) for high pressure model
Temperature	-60° to 250° F (-29° to 121° C)
Flow Rate	30 to 220 gpm (7 to 50 tons/hr) for standard model

Wash Cycle Time	5 to 30 minutes
Nozzle Rotation Speed	2 to 20 rpm

### OVERALL DIMENSIONS:

Height	122 in. (310 cm)
Diameter	42 in. (107 cm)
Width	6.0 in. (15.2 cm) including nozzle housing

### MINIMUM ENTRY OPENING:

Pin Drive	Dual: 12.6 in. (32.0 cm) Triple: 11.4 in. (29.0 cm)
Optional Clutch Drive	Dual: 6.6 in. (16.8 cm) Triple: 9.5 in. (24.1 cm)

### WEIGHT:

Dual	26 lb. (11.8 kg)
Triple	27 lb. (12.3 kg)

### DUAL INLET CONNECTION:

Standard	2 in. NPT female and 2 1/2 in. quick disconnect male
Optional	2 in. NPT female and 2 1/2 in. NSF (NH) hose thread male

### CONSTRUCTION:

Type 316 SS or Silicon Bronze for all main body housings and component parts. Compounded plastic (PPS, nylon, etc.) main housing bearings. Rotor and gear box shafts are hardened stainless and, for specific applications, supplied with plasma-sprayed ceramic coating and carbide thrust washer. Rotor shaft bearings are tungsten carbide. Rotary shaft and housing seals are spring-loaded reinforced PTFE/ETFE. Static seals are fluorocarbon, nitrile, chloroprene, Kalrez, EPDM, etc., as required. Drive gear system has new improved design and stainless-PTFE/ETFE-carbide composite construction.

**NEWS RELEASE****INCREASED PRODUCTION CAPACITY OF REACTOR VESSELS  
WITH NEW C.I.P. AUTOMATION**

A major chemical processor recently installed a newly developed Clean-In-Place Retraction Cleaning System, anticipating a 5 to 15% additional production capacity through virtual elimination of reactor downtime with complete automation.

A patented retraction device inserts a hydraulic rotary nozzle through a valve and follows a programmed cleaning procedure using only plain hot water to scrub and wash off hard-to-remove, layered-on or baked-on reactor deposits.

Compared to traditional methods involving the use of chemical "soak and stir" or hand-held water blasting devices, the system eliminates the need to open up the tank for batch-to-batch cleaning purposes.

Since the process products are not exposed nor residual vapors or fumes are allowed to escape, atmospheric pollution or product contamination hazards are also eliminated.

The system employs moderate pressure of 300 to 600 psi as compared to high pressure blasting devices that require 5,000 to 10,000 psi. Solid hitting water jets are effective beyond 6 to 20 feet at volumes of 40 to 85 gpm. A unique steam pump-amplifier supplies effective discharge pressures at four to six times input steam pressures. Where in-plant steam is available, this nonmechanical pump replaces the need for high pressure pumps, resulting in added operation and maintenance savings.

This development is economically significant in those plants who can use the extra production capacity or operating savings with capital payback of one to two years.

System and engineering services are offered on a guaranteed performance basis by the Equipment Division of Sybron Chemicals Inc., 121 So. Maple Avenue, So. San Francisco, California, 94080, Tel. #800-356-7807.

March 8, 1989

**Gamajet Equipment Division**  
SYBRON CHEMICALS INC.

21066 Alexander Court, Hayward, California 94545 (415) 293-9040, (800) 356-7807  
Telex 34-9479, Telefax (415) 293-9045

The Gamajet Retraction System is designed for fast, automatic, in-place jet-scrubbing and jet-washing of enclosed or pressurized vessels without exposing process products or gases to the atmosphere. It answers current problems and contributes to production efficiency in the PVC, resin, polymer, biochemical and other critical process industries.

Powered by the pressurized liquid cleaning solution at economical pressures (500 to 1000 psi) and effective flow rates (30-150 gpm), powerful jet streams reach 15 to 25 feet scrubbing and rinsing effectiveness, heretofore not offered by water-blasting and spray valve devices commonly used today.

Recent field evaluations have shown that this system with only 500-600 psi and 60-80 gpm at 180-200° F reactor cleaning conditions was more than adequate to clean, in one single step without any chemical cleaning aids, acrylic emulsion and other tough deposits. This resulted in savings on chemicals and effluent disposal costs.

Other than plain water, the pressurized liquid solution may be any chemical solvent, caustic or acid, depending on the tank cleaning requirement.

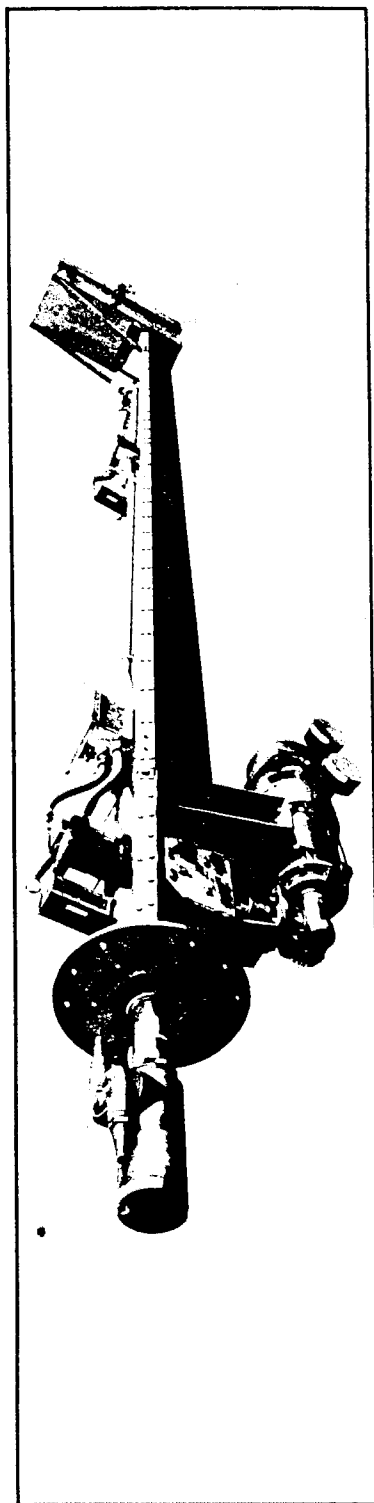
The programmable control system allows the unit to be operated manually, remotely, or integrated with a centralized plant computer facility. Flow rates, nozzle rotation speeds, multi-wash cycle sequences or cleaning procedures can be programmed on-site.

A Multi-Tank Retraction System with an overhead rail track enables the use of one retraction unit for a series of tanks. Thus, only the separable isolation valve portion of the system is mounted on each tank, for additional savings.

Safety hazards to personnel and product quality problems are minimized by the system. With remote operation and monitoring, labor and operating costs can also be reduced. Tank down-time is reduced if not eliminated.

#### TECHNICAL SPECIFICATIONS

Vessel Entry Opening:	14" minimum inside diameter 8" minimum with optional nozzle position sensor
Maximum Vessel Pressure:	To 150 psi with knife gate valve As required with wedge gate or ball valve
Insertion Mode/Distance:	Vertical to 200" Horizontal to 72"
Installation Clearance:	60" minimum
Jet Washing Pressure:	100-1000 psi
Jet Washing Volume:	30-150 gpm
Jet Washing Temperature:	To boiling (250° F maximum)
Options:	Multi-Tank System, insertion distance, internal pressure rating, nozzle position sensor, manual or electronic controls, etc., to fit application requirements.



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#### GAMAJET EQUIPMENT DIVISION

SYBRON CHEMICALS INC. / 21066 ALEXANDER COURT / HAYWARD, CALIFORNIA 94545 / (415) 873-1750 / TELEX 34-9479 / TELEFAX (415) 873-0876

## DESCRIPTION

An automatic CIP system which inserts the Gamajet rotary cleaner into a reactor or process vessel and then retracts and stores the Gamajet in a module outside the tank. Pressurized hot liquid jets soften, cut and wash off hard, tenacious deposits without necessity of costly chemical aids, high-pressure pumps and manual lances. The system enables fast and easy cleaning on a programmed schedule or batch-to-batch basis. Build-up or layering of hard, tenacious deposits is prevented, eliminating the usual need for hand-held high-pressure lances or "chemical soak and stir" cleaning methods.

The Gamajet gives a precise, tight spray pattern insuring a thorough jet-scrubbing and washing procedure automatically without manually opening the tank.

## ADVANTAGES

**Low Capital and Operating Costs.** The complete automated system can be installed at  $\frac{1}{3}$  to  $\frac{1}{2}$  of the total costs for currently used high-pressure 5,000-15,000 psi nozzles and lance systems.

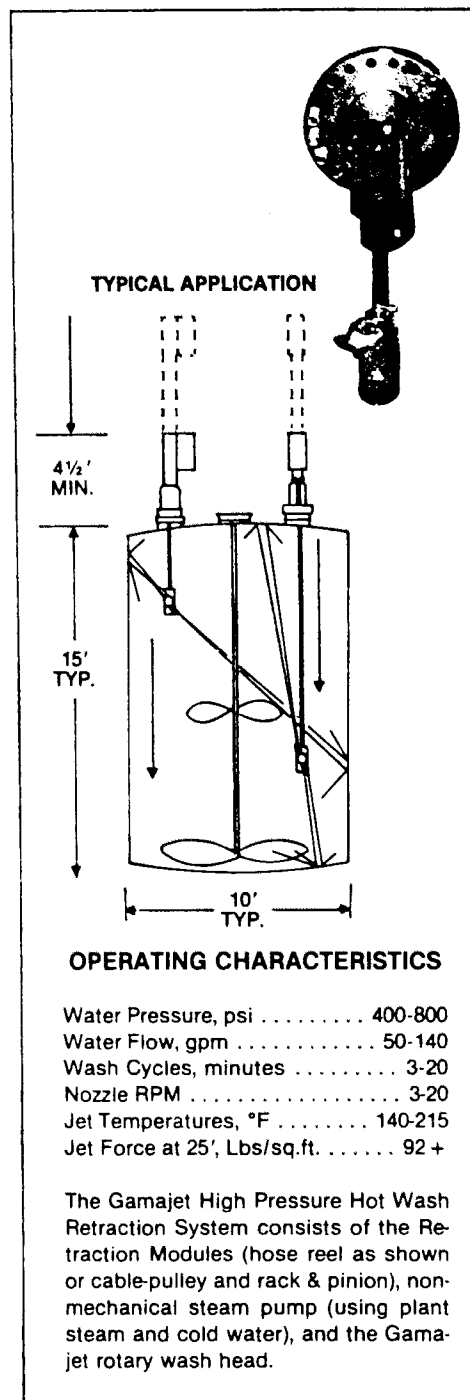
**Tank Downtime Is Minimized or Eliminated.** This results in increased production capacity and maintenance savings.

**Product quality is improved** due to batch-to-batch cleaning efficiency.

**Product contamination or atmospheric pollution** is prevented by the retraction features which eliminates opening and cleaning the tank manually.

**Hazards to men, equipment and the environment** due to exposure to chemical vapors, gases, or to use of high-pressure water blasting nozzles are minimized or eliminated.

**Guaranteed Performance.** We provide installation drawings and engineering assistance, along with our performance guarantees.



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## GAMAJET EQUIPMENT DIVISION

SYBRON CHEMICALS INC. / 121 SO. MAPLE AVENUE / SO. SAN FRANCISCO, CALIFORNIA 94080 / (415) 873-1750 / TELEX 34-9479 / TELEFAX (415) 873-0876

# Introducing the Gamajet Retraction System.

**Now you can jet-clean your tanks without opening them up.**

Finally, a complete tank jet-washing system for processes of resins, polymers, acrylics, and bio-chemicals. No matter how gummy your tanks become, this completely automated system can quickly jet-clean just about any kind of deposit—with or without chemical cleaning agents.

It operates economically at low to medium pressures (50 to 1,000 psi), at effective low-medium-high flow rates (30 to 150 gpm), and at sanitizing temps. (180°-215° F)—yet it delivers the cleaning efficiency of much higher priced water blasting systems that don't offer the retraction feature.

We are the exclusive manufacturer/marketer of Gamajet tank cleaning machines.

***Still, Nothing Cleans Like Gamajet.***

**SYBRON|Gamajet®**

21066 Alexander Court, Hayward, CA 94545 (415) 293-9040 Fax: (415) 293-9045 Telex: 34-9479

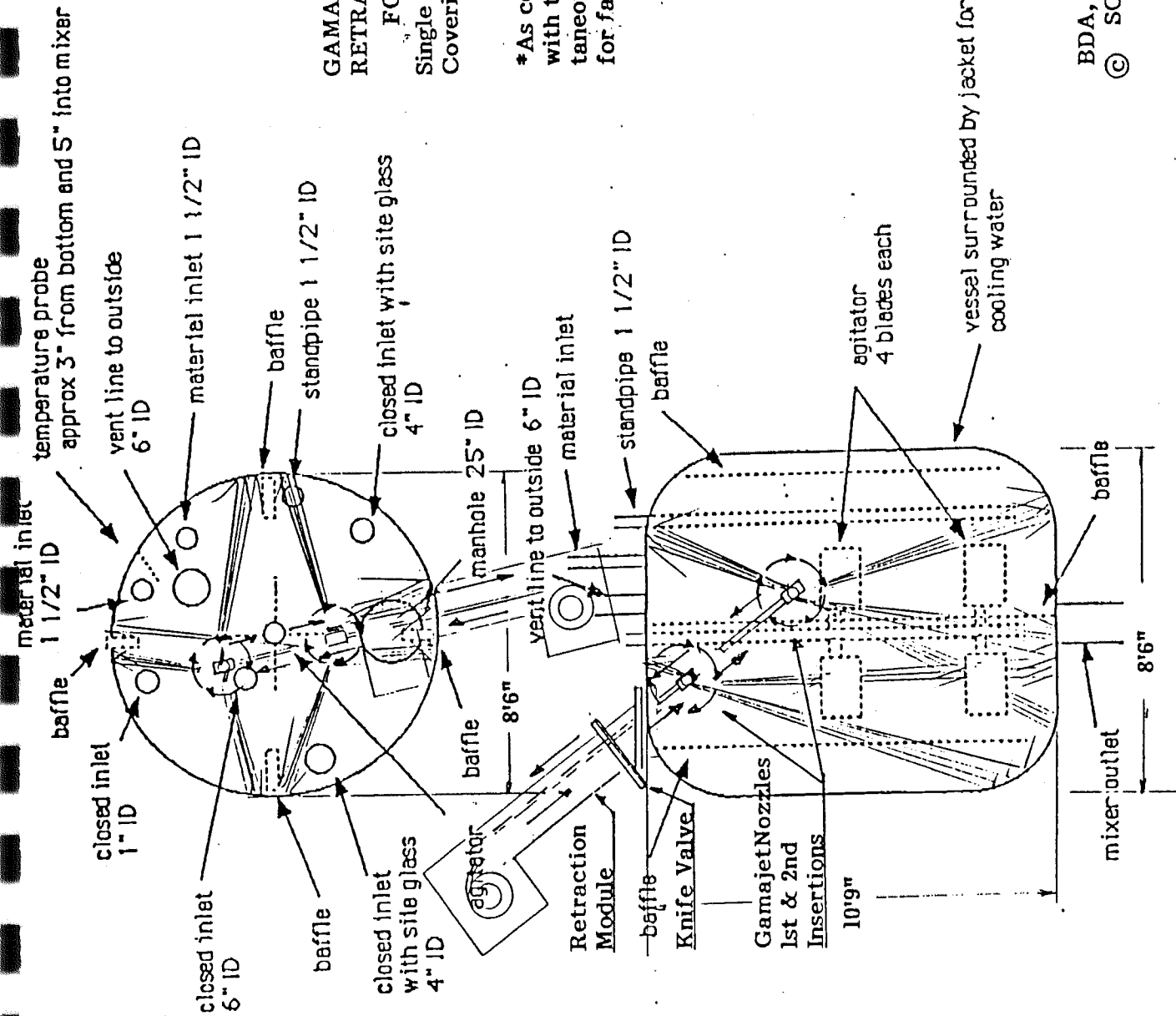


Gamajet Retraction System  
shown with optional 16' extension

**Degassing becomes a thing of the past, because the retraction design eliminates exposure to the atmosphere. The tank remains sealed. Your product cannot become contaminated and toxic gases cannot escape, thereby minimizing possible EPA violations.**

**Before you invest in any cleaning equipment or new tanks, look carefully at the efficiency and economy of the Gamajet Retraction System. Call today.  
1-800-356-7807**





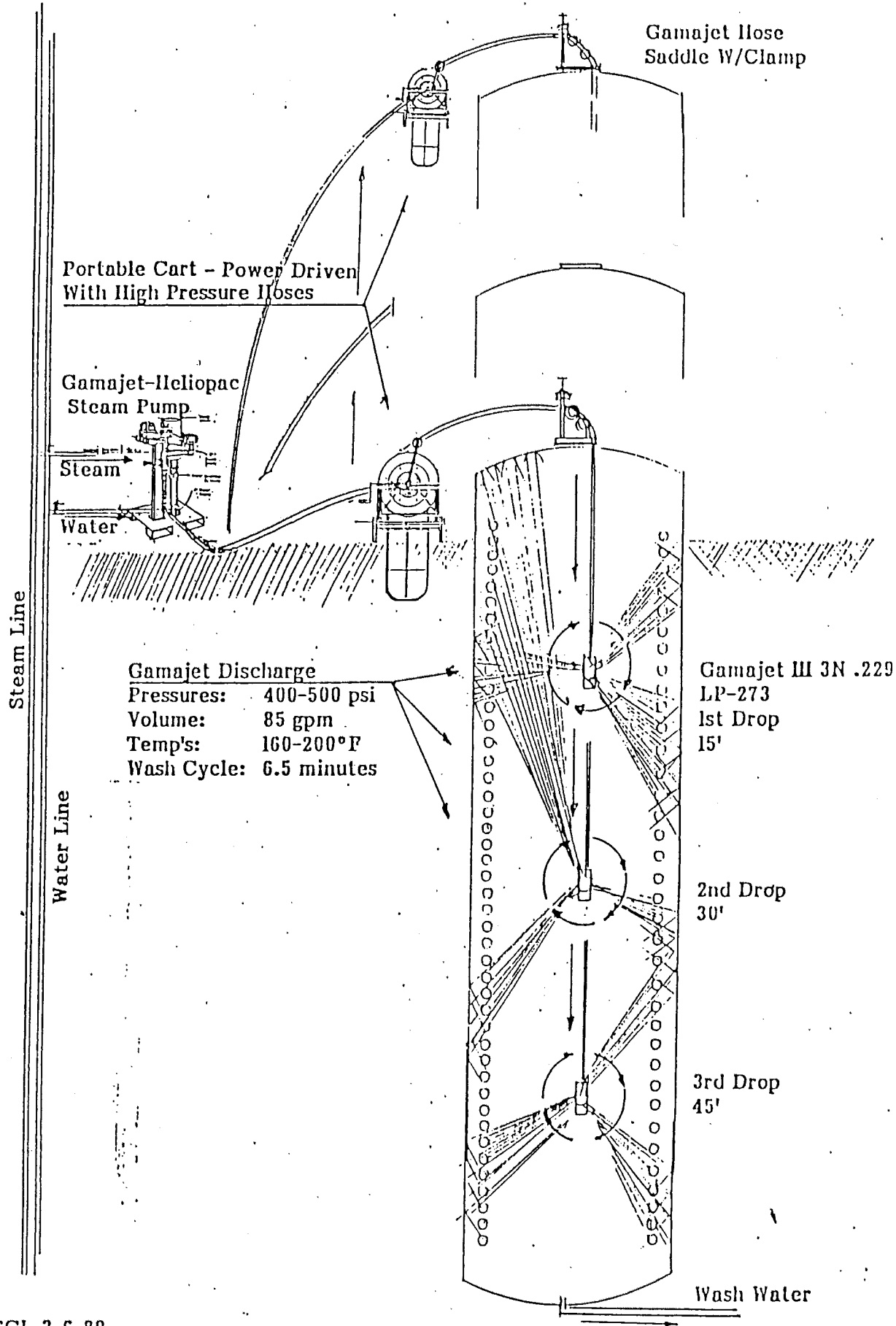
GAMAJET HIGH PRESSURE/HOT WASH  
RETRACTION SYSTEM

FOR CHEMICAL REACTORS  
\*Single Unit Insertion - 2 Step Cleaning  
Covering all Baffles/Agitators

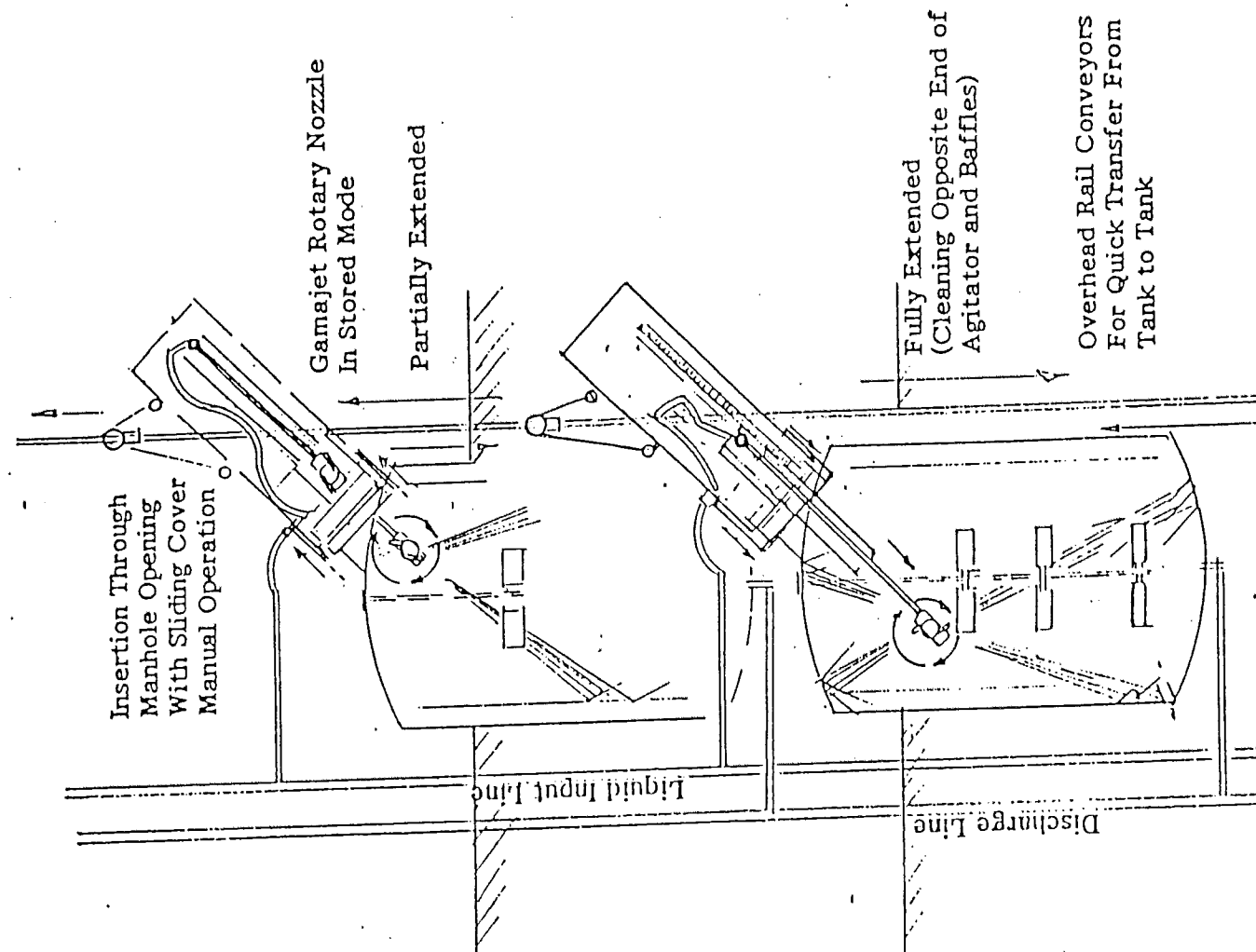
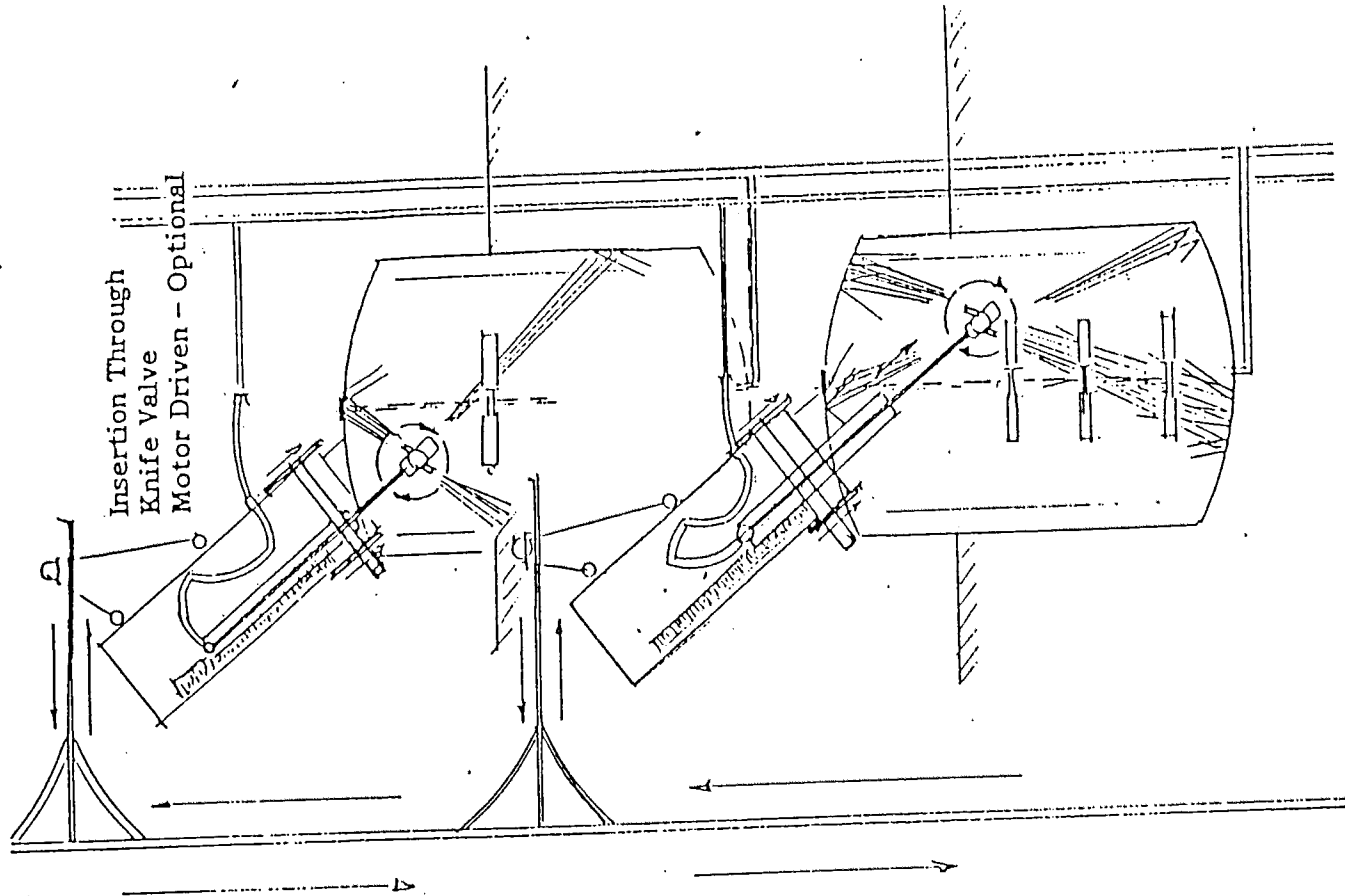
\*As compared to a 2-unit insertion vertically  
with two Gamajet nozzles operated simul-  
taneously, covering all blind or hidden areas,  
for faster cleaning.

BDA, 2-17-89  
© SCL Gamajet Div.

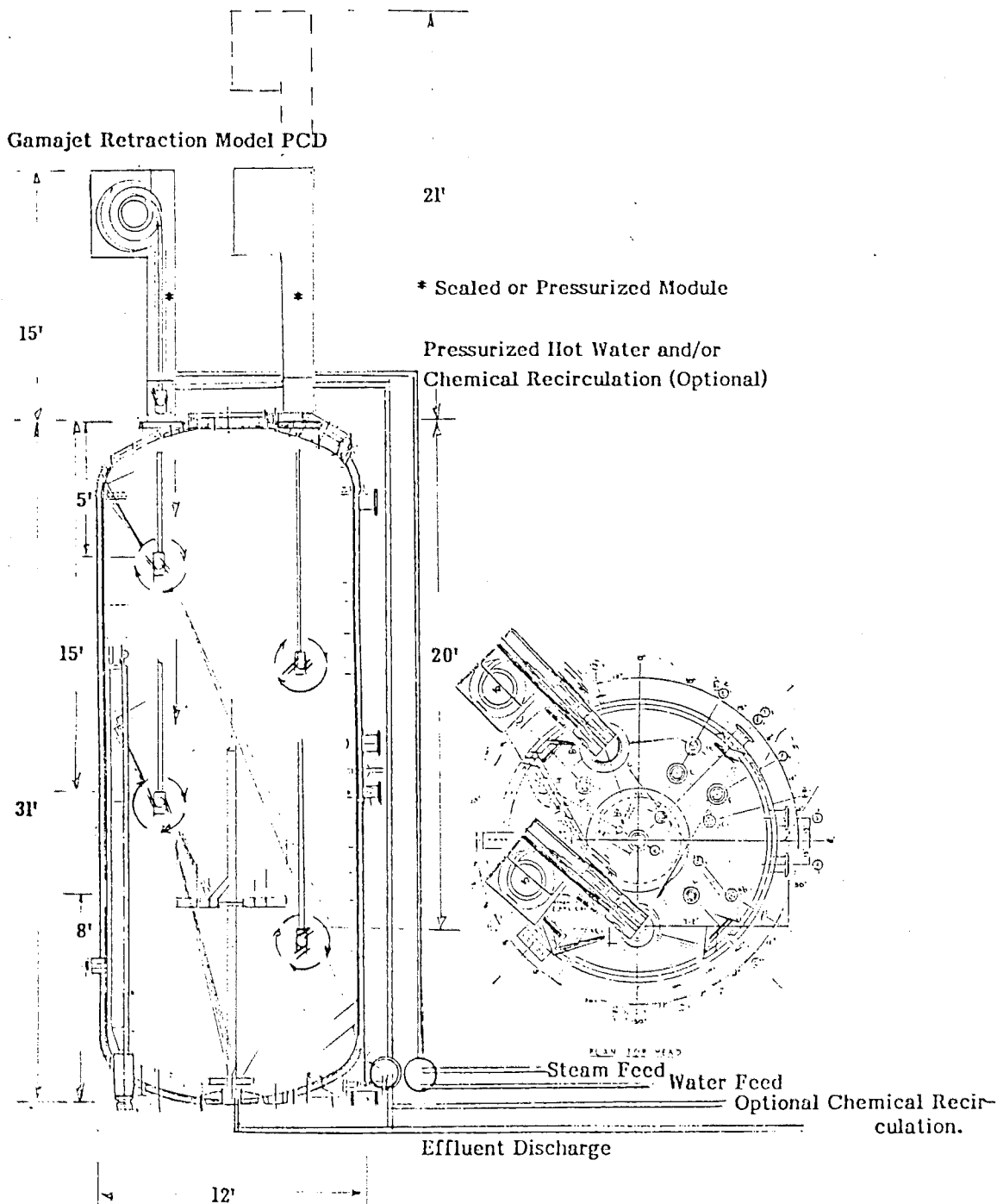
**GAMAJET HIGH PRESSURE-HOT WASH  
PORTABLE RETRACTION SYSTEM**



# GAMAJET PORTABLE RETRACTION SYSTEM



**FIXED C.I.P. REACTOR CLEANING SYSTEM**  
**With GAMAJET RETRACTION & ROTARY MACHINE**  
**(Electronic Controls and Sensors)**



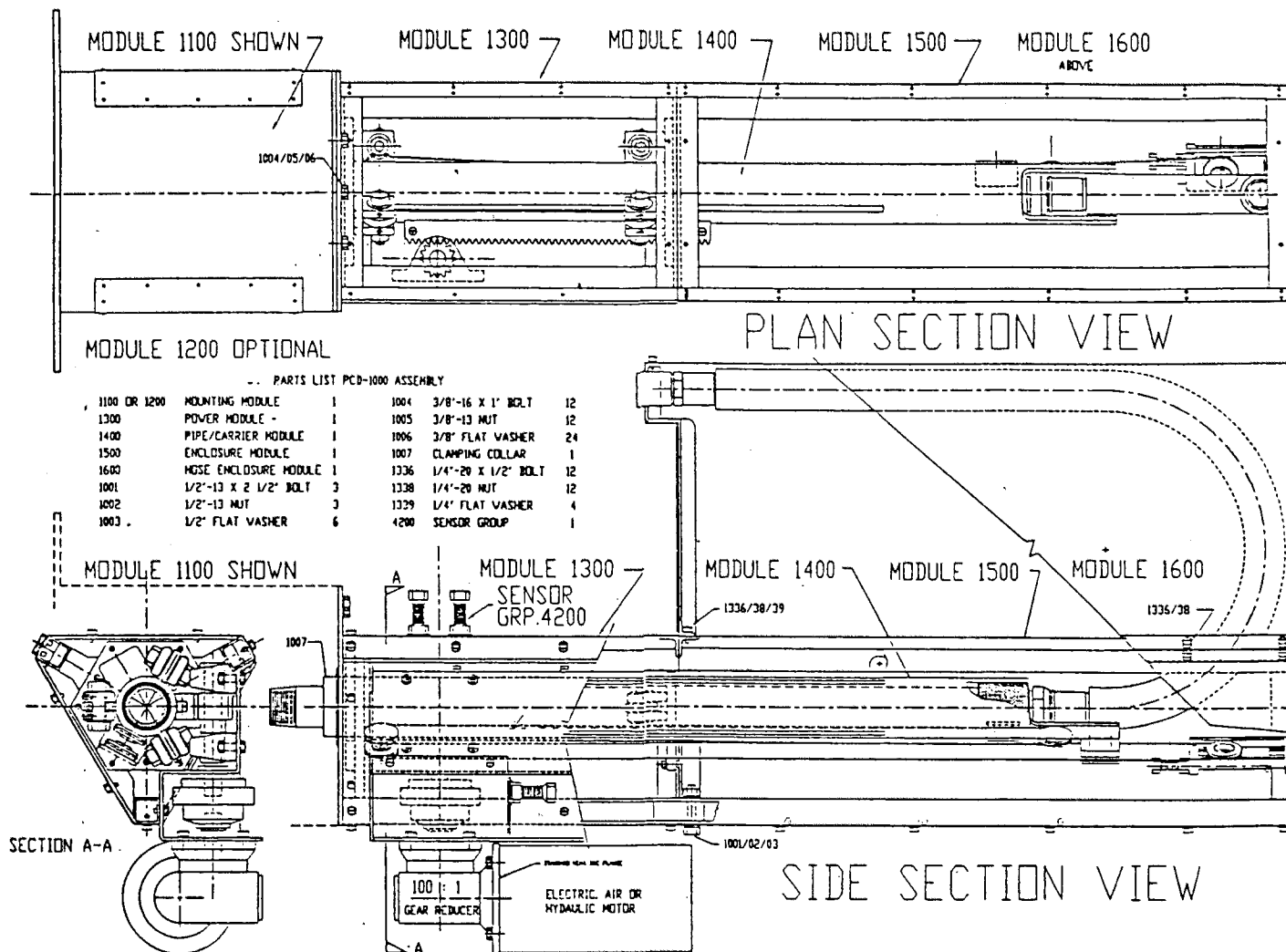
© Sybron Chemicals Inc.  
 090490

The information contained in this bulletin is to the best of our knowledge accurate; but since the circumstances and conditions to which it may be used are beyond our control we do not accept liability for any loss or damage that may occur nor do we offer any warranty of immunity against patent infringement.

### GAMAJET EQUIPMENT DIVISION

SYBRON CHEMICALS INC. / 21066 ALEXANDER COURT / HAYWARD, CALIFORNIA 94545 / (415) 293-9040 / (800) 356-7807 / TELEX 34-9479 / TELEFAX (415) 293-9045

#### SCHEMATIC DRAWING



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012089

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**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

**RECORD OF TELEPHONE CONVERSATION**

DATE 2/21/92

TIME 9:30 AM

PAGE 1 OF 1

FROM: MYRON SCHULTZ TO: DAVID YARED  
COMPANY: UE & C COMPANY: NLB CORP.  
PHONE: \_\_\_\_\_ PHONE: 313-624-5555

REFERENCE/PROJECT NO.: 6299.001 NREL

SUBJECT: FERMENTING / DIGESTER TANKS - TANK C.I.P. SYSTEM

TOPICS OF CONVERSATION: \_\_\_\_\_

DAVE SAID THEY HAVE DESIGNED MANY TYPES OF TANK  
CLEANING SYSTEMS TO CLEAN BOTH LARGE & SMALL TANK  
HE WILL SEND ME SOME INFO ON THEIR COMPANY, AND  
WILL HAVE ONE OF THEIR SALES ENGINEERS CONTACT  
ME. (FOLLOW-UP)

DISTRIBUTION

FORM 62-20  
REVISED 5/8

February 27, 1992



*Manufacturer of the National Liquid Blaster*

Mr. Myron Schultz  
United Eng. & Constructors  
P.O. Box 5888  
Denver, CO 80217

**29830 Beck Road • Wixom, Michigan 48393-2824**  
**TELEPHONE (313) 624-5555 • FAX (313) 624-0908**

Dear Mr. Schultz:

This is in response to your telephone inquiry of February 24, 1992. Enclosed you will find product information which describes NLB Reactor and Tank Cleaning Systems.

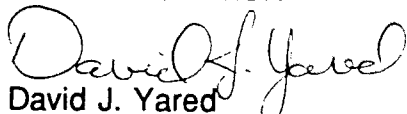
NLB is the leading manufacturer in North America of high pressure waterblast cleaning systems rated for pressures up to 20,000 psi. NLB supplies equipment and accessories to many major industries throughout the U.S. and Canada. Our reactor cleaning systems which have replaced chemical and manual cleaning, greatly reduce downtime and help increase a vessel's overall productivity. After 21 years of business, NLB maintains a solid reputation based on the integrity of the design, manufacture and service of its high pressure waterblasting equipment.

NLB reactor cleaning systems which have replaced chemical and manual cleaning, greatly reduce downtime and help increase a vessel's overall productivity.

Many major petrochemical producers use our systems to clean reactors from the very smallest to vessels in excess of 40,000 gallons. Plastics, resins and elastomer's like PVC, PVA, ABS, SBR, to name a few, are commonly cleaned with NLB systems.

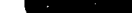
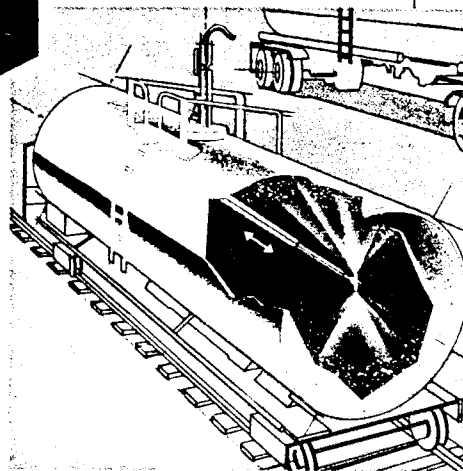
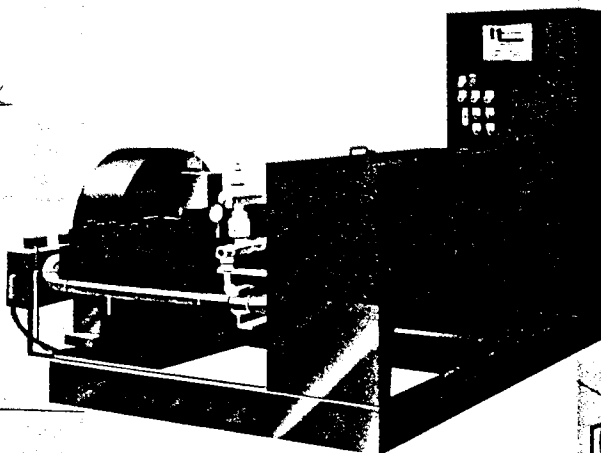
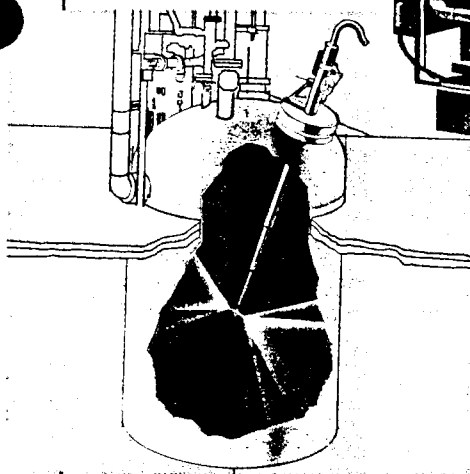
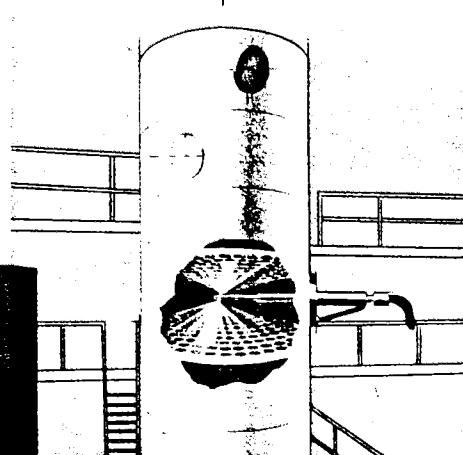
Thank you for your interest in NLB Corporation. If you have questions or need additional information, please contact our sales engineer Mr. Dan Williams at our Texas office. He can be reached at (713)471-7761.

Very truly yours,  
NLB CORPORATION

  
David J. Yared  
Marketing Manager

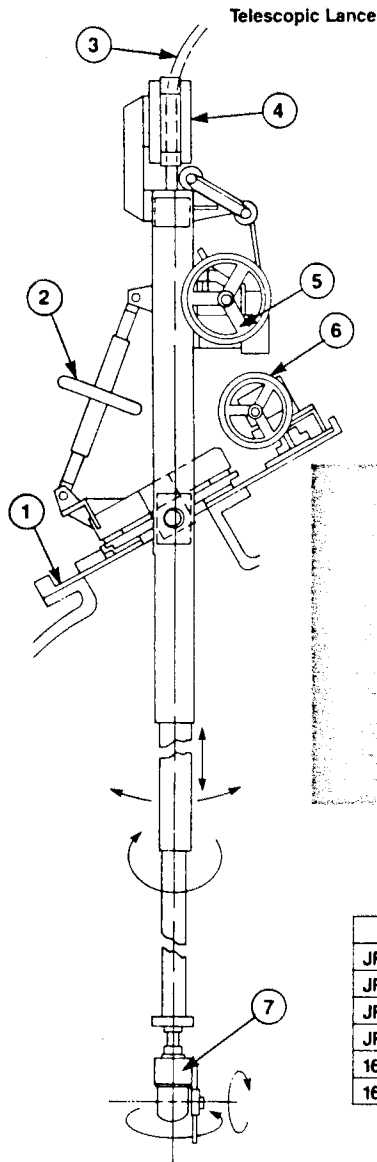
DJY:dak

Enclosures



**NLB Corp.**

# Nozzles



## Telescopic Lance

1. Manhole base
2. Inclination tilting handle
3. High-pressure hose
4. Hose guide
5. Extension telescopic handle
6. Turning handle base rotation
7. NLB nozzle

## Telescopic Lance

The NLB Telescopic Lance is used in larger vessels or in areas where overhead height is restricted. This lance positions the 3-D head within the vessel. External hand wheels are used to manipulate extension/retraction, inclination, and rotation. NLB Telescopic Lances are available in reaches of up to 259 inches.

## Swivel Socket Lance Adapter Model 5996

The Swivel Socket Lance Adapter is used to locate the 3-D cleaning head into the required working position. With this adapter, the lance has three movements; extension/retraction, inclination, and rotation. This lance adapter is normally used in smaller vessels and is ideal for horizontal applications.

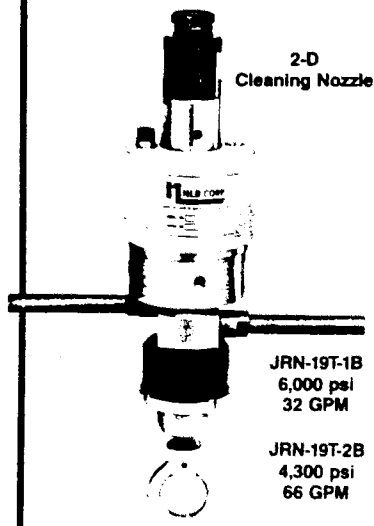
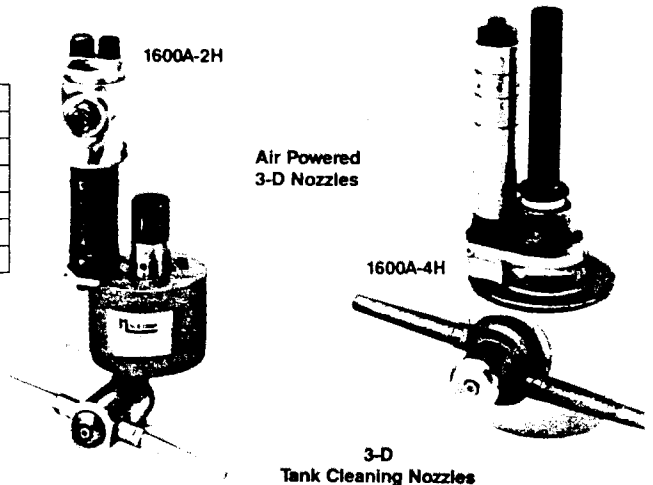
## NLB 3-D Tank Cleaning Nozzles

NLB 3-D Spin-Jet® Nozzles deliver two high velocity jets of water from a revolving/rotating head. 3-D heads may be rotated by the reaction energy of the high pressure water or an inlet air supply. In operation, the jet nozzles rotate vertically while the body rotates horizontally. The combination of these two movements results in 360° spherical cleaning coverage. Rotational speed adjustment allows for proper impact time in a variety of work conditions.

When using 3-D Spin-Jet Nozzles, there is no longer a need for a man to enter a tank for cleaning. Using this system, cleaning downtime has been dramatically reduced.

3-D TANK CLEANING NOZZLES

Model	Pressure	Volume
JRN-19T-1H	6,000 psi	32 GPM
JRN-19T-2H	6,000 psi	53 GPM
JRN-19T-4H	8,000 psi	108 GPM
JRN-19T-5E	10,000 psi	34 GPM
1600A-2H(Air)	10,000 psi	50 GPM
1600A-4H(Air)	10,000 psi	100 GPM

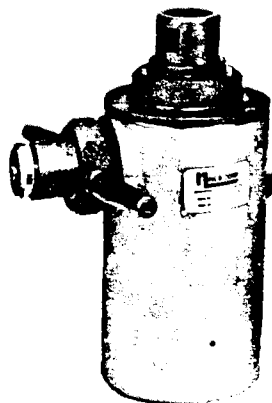


JRN-19T-1B  
6,000 psi  
32 GPM

JRN-19T-2B  
4,300 psi  
66 GPM



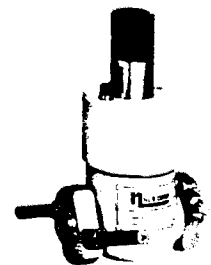
JRN-19T-5E



JRN-19T-4H

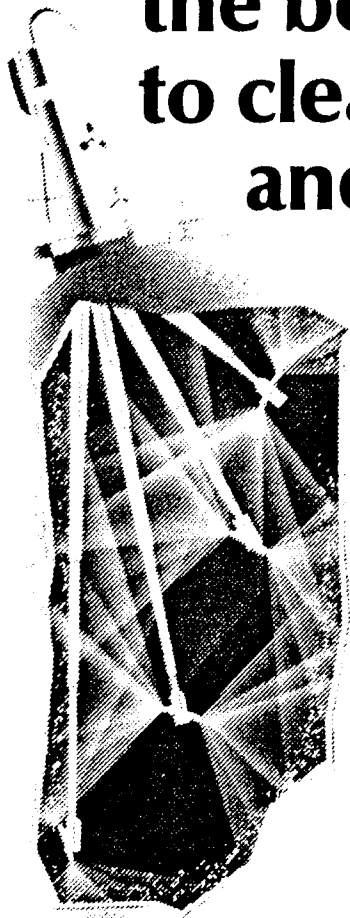


JRN-19T-2H



JRN-19T-1H

# High pressure water... the best way to clean reactors and tank interiors.



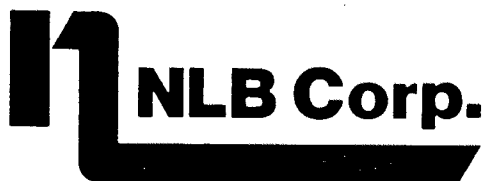
NLB high pressure water-jet reactor/tank cleaning systems help you avoid environmental problems of chemical and hazardous waste disposal.

NLB waterjet cleaning is the only fast, efficient and non-polluting answer to industrial cleaning problems. Call or write for details on how to put water to work for you.

NLB field-proven units, equipment and accessories handle the toughest jobs — removing flaking paint, rust, grease, and heavy paint build-up on surfaces; cleaning concrete, pipes and tubes; and cleaning steel to a "white" metal finish.

NLB waterjet cleaning is the only fast, efficient and non-polluting answer to today's cleaning problems. Call or write for details on how to put water to work for you.

**The Industry Leader in  
High Pressure Water Blasting Technology**



**National Liquid Blasting Corporation**

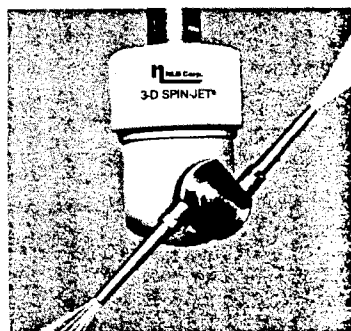
29830 Beck Road • Wixom, MI 48393-9902 • (313) 624-5555 • Fax (313) 624-0908

## NLB High Pressure Waterjet Cleaning Systems up to 10,000 psi, Solve Problems Inherent to Reactor/Tank Cleaning.

In the normal cleaning of reactor/tank interiors, several factors exist which can lead to excessive costs, environmental concerns and liability.

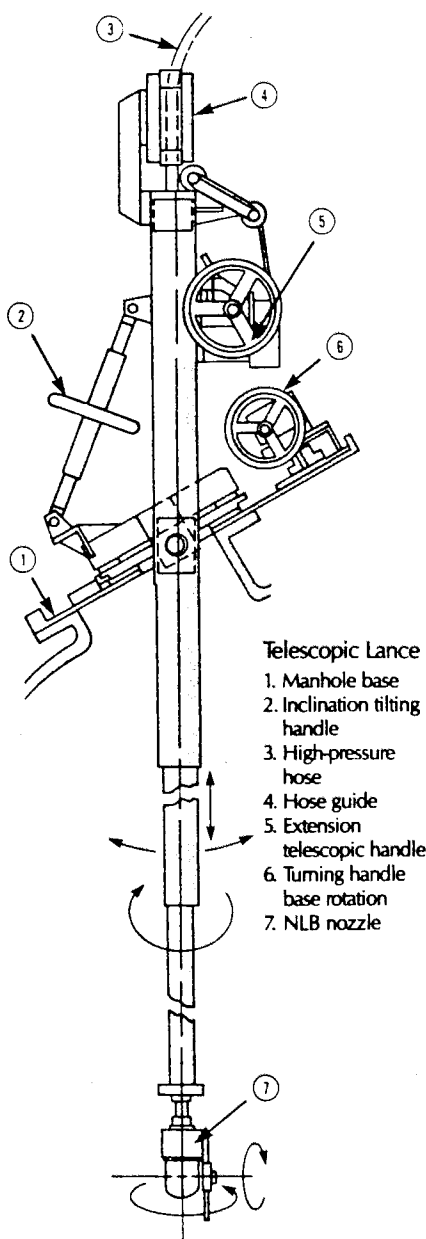
The use and disposal of solvents and caustics, as well as manual cleaning methods lead to extended cleaning times and increased downtime, which contribute to soaring tank cleaning costs. And there is the potential for expensive liability claims when workers are exposed to the product, caustics and solvents while working inside or near a vessel.

### The NLB 3-D SPIN-JET® Nozzle and Swivel Socket or Telescopic Lances Efficiently Remove 100% of Interior Product Build-up While Minimizing Downtime and Cleaning Costs.



#### The NLB 3-D SPIN-JET Nozzle:

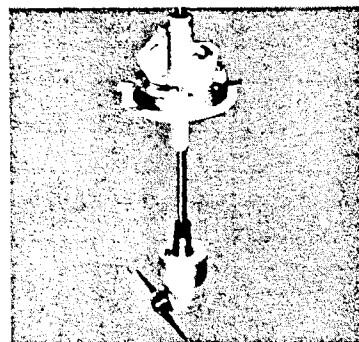
The 3-D SPIN-JET nozzle delivers two high velocity jets of water from its revolving/rotating head. The 3-D head rotates by the reaction energy of only the high pressure water. In operation the jet nozzles rotate vertically while the body of the 3-D head rotates horizontally. The combination of these two movements result in a 360 degree spherical cleaning pattern. A speed adjustment on the 3-D head allows for a variety of rotational speeds which in turn allow the high pressure water to have the proper impacting time.



Telescopic Lance

1. Manhole base
2. Inclination tilting handle
3. High-pressure hose
4. Hose guide
5. Extension telescopic handle
6. Turning handle base rotation
7. NLB nozzle

The Swivel Socket Lance is used to locate the 3-D cleaning head into the required cleaning position within the vessel. The lance has three (3) movements, extension/retraction, inclination, and rotation. This lance is normally used in smaller vessels and is ideal for use in horizontal applications such as stripping columns, blow down tanks, flash tanks, and hopper cars. The swivel socket mounts to the vessels manway with a custom designed manway adapter.



The Telescopic Lance is used in larger vessels or in areas where overhead height is restricted. The lance positions the 3-D head within the vessel by operating external handwheels to achieve extension/retraction, inclination, and rotation. The lance is mounted to the vessels manway opening with a custom designed manway adapter. NLB telescopic lances are available in pre-engineered sizes ranging from 20" to 259" and are capable of service to reactor/tank heights ranging from 60" to 334". Custom sizes for specific applications are available. Fully automated robotic telescopic lances are also available.

TELESCOPIC LANCE SELECTION CHART

JTL3-3500H-3/4	33.9	137.8	158-177
JTL3-4500H-3/4	46.9	177.2	197-216
JTL3-5500H-3/4	59.8	216.5	237-255
JTL3-6500H-3/4	72.2	255.9	276-295
JTL4-3500H-3/4	20.9	137.8	158-177
JTL4-4500H-3/4	30.7	177.2	197-216
JTL4-5500H-3/4	40.6	216.5	237-255
JTL4-6500H-3/4	50.4	255.9	276-295
JTL4-7500H-3/4	60.2	295.3	315-334
JTL3-3500H-1-1/4	38.8	137.8	158-177
JTL3-4500H-1-1/4	51.8	177.2	197-216
JTL3-5500H-1-1/4	65.0	216.5	237-255
JTL3-6500H-1-1/4	78.1	255.9	276-295
JTL4-3500H-1-1/4	26.0	137.8	158-177
JTL4-4500H-1-1/4	35.8	177.2	197-216
JTL4-5500H-1-1/4	45.7	216.5	237-255
JTL4-6500H-1-1/4	55.5	255.9	276-295
JTL4-7500H-1-1/4	65.4	295.3	315-334

## NLB Automated, Between-Batch Cleaning.

NLB Automated Between-Batch Tank Cleaning Systems eliminate or greatly reduce prolonged and expensive cleaning. Cleaning takes a fraction of the time when compared to other methods and is accomplished without the use of chemicals, solvents or caustics.

Of particular importance in high production vessels is an NLB dedicated system which saves valuable production time since the cleaning system is installed on the vessel.

Cleaning takes place immediately after each production batch. By cleaning between batches, the product is removed from the vessel before it can dry or build upon itself.

These cleaning systems are custom designed and manufactured to meet each clients' individual requirements and specifications. NLB's staff of application Sales Engineers and Manufacturing Engineers are experienced in evaluating your needs and responding to them.

Important considerations in designing these systems include:

- Type of product manufactured
- Vessel size
- Internal vessel configuration
- Overhead room.

NLB 3-D nozzle  
in home position

8" to 14"  
nozzle openings

High pressure  
hose reel

Lance drive  
mechanism

3-D nozzle  
parking chamber

Floor line

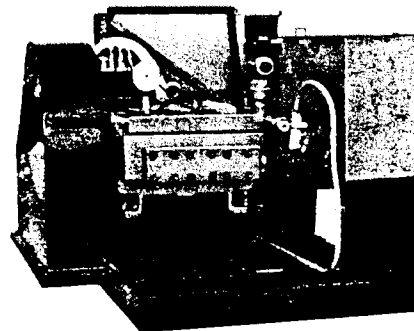
Nozzle at  
full extension

## NLB High Pressure Pump Units.

NLB high pressure pump units operate at pressures up to 20,000 psi. All models feature rugged, heavy-duty NLB industrial, high pressure pumps built for continuous duty operation. Electric motor drive units are skid or dolly mounted. Industrial diesel engine models are also available.

NLB systems are thoroughly tested before shipment. The units are available to purchase, lease or rent.

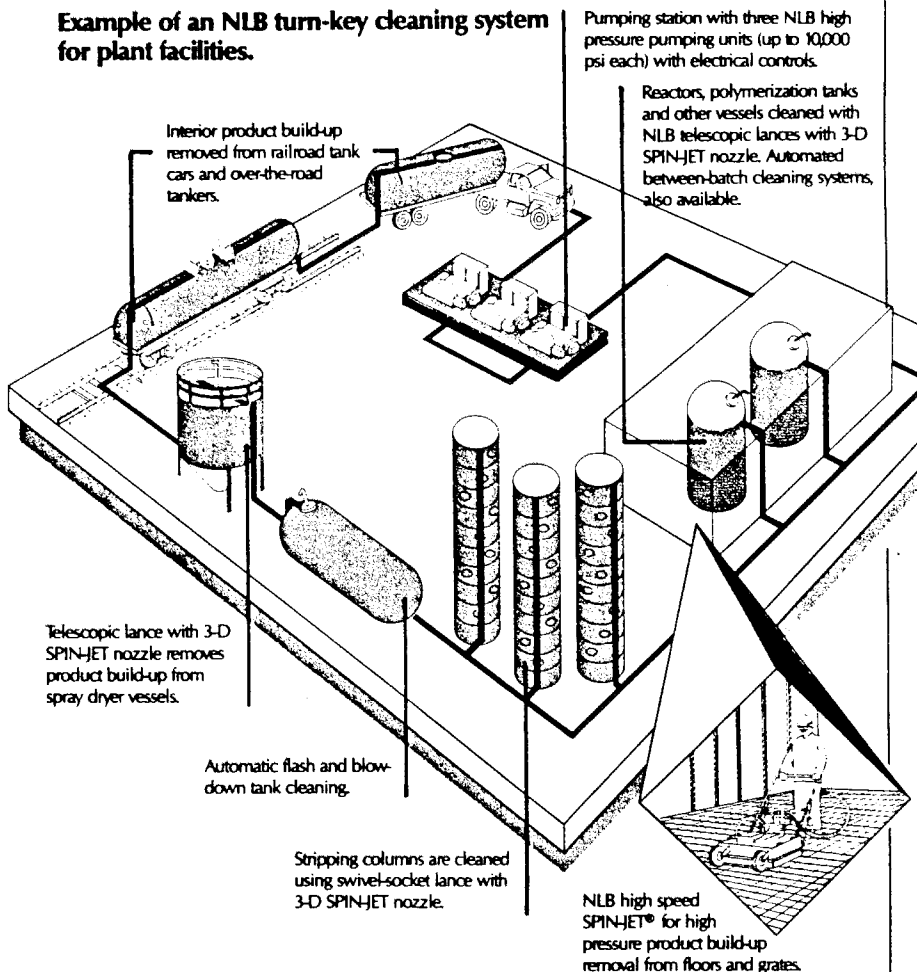
10100E	100	15	10,000
8100E	100	19	8,000
6100E	100	23	6,000
10150E	150	25	10,000
8150E	150	32	8,000
6150E	150	40	6,000
10200E	200	34	10,000
8200E	200	42	8,000
6200E	200	56	6,000
10250E	250	43	10,000
8250E	250	54	8,000
6250E	250	65	6,000



## The NLB Difference

When it comes to interior tank and reactor cleaning projects, NLB offers much more than just a pump and cleaning nozzle. We take pride in our reputation as the "Systems People". We see that you get not only the best cleaning equipment available, but also a fully integrated system to fit the special needs at your plant. From the 3-D SPIN-JET® nozzle, to the telescopic lance, to the continuous duty NLB high pressure pumping system including all pipe and valves, to completely automated electric controls — NLB's engineers will custom design a total system to match your requirements. Totally automated after batch cleaning systems are also available. They are permanently attached to the vessel and are isolated from the actual process. They are designed to contain fumes, telescope and clean-up automatically after each batch. These systems allow increased production capability, and can be push button or computer controlled.

## Example of an NLB turn-key cleaning system for plant facilities.

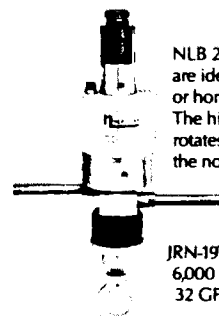


## Nozzle Selection

NLB 3-D SPIN-JET Tank cleaning nozzles come in a variety of sizes with a range of nozzle pressure and volume capacities to fit most any reactor tank or vessel cleaning application. Now NLB even offers two sizes of air powered tank cleaning heads. Consult NLB to determine the 3-D nozzle which best fits your needs.

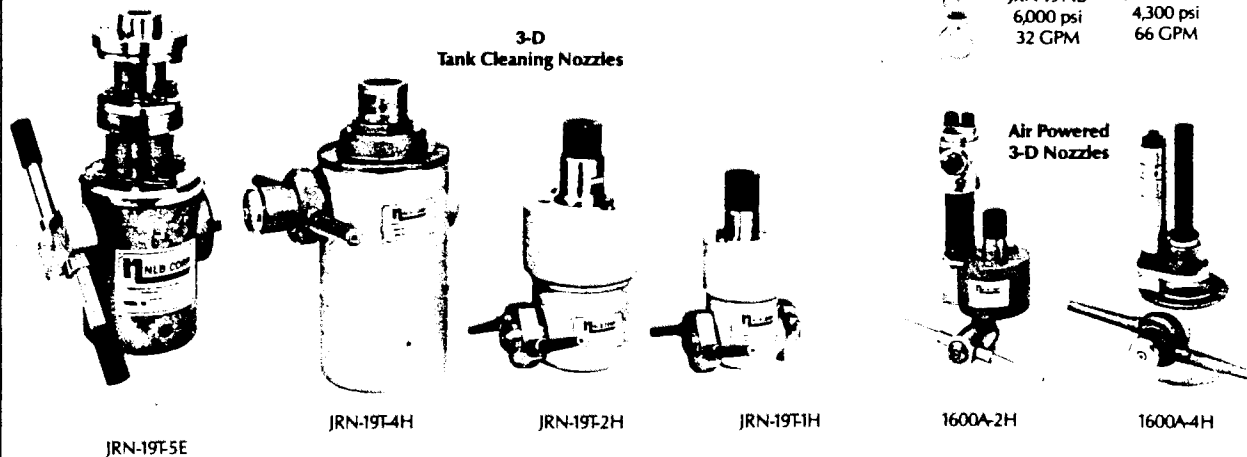
### 3-D TANK CLEANING NOZZLES

MODEL	PRESSURE	VOLUME
JRN-19T-1H	6,000 psi	32 GPM
JRN-19T-2H	6,000 psi	53 GPM
JRN-19T-4H	8,000 psi	108 GPM
JRN-19T-5E	10,000 psi	34 GPM
1600A-2H (Air)	10,000 psi	50 GPM
1600A-4H (Air)	10,000 psi	100 GPM



NLB 2-D ROTATING NOZZLES are ideal for cleaning vertical or horizontal pipes and stacks. The high pressure spray rotates perpendicular to the nozzle body.

JRN-19T-1B 6,000 psi 32 GPM  
JRN-19T-2B 4,300 psi 66 GPM



## NLB Systems for a Wide Range of Applications: Interiors of Chemical Reactors, High-molecular Polymerization Tanks and other Vessels.

Examples of plastics, resins and elastomers presently being cleaned: ABS, PS, PU, PVAC, PVC, SAN, BR, CR, IR, NBR, SBR. Other industries with high pressure tank cleaning applications: breweries, distilleries, dairies, food plants, paper and cellulose plants, rubber, highway and railroad tankers, marine, nuclear and mineral/oil industry.

### BENEFITS OF THE NLB SYSTEM

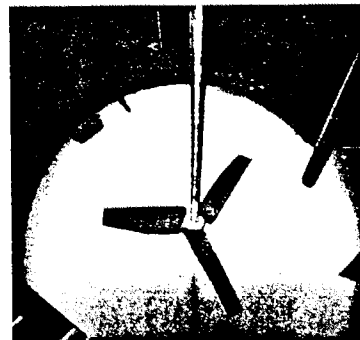
1. **Complete "matched" system** NLB cleaning systems are custom designed to fit in your plant as a totally integrated cleaning system.
2. **Safety** — The systems provide greater safety by eliminating the need for personnel to enter a tank which contains toxic residues or gases dangerous to human health.
3. **Economy** — Eliminates costly use of caustics and solvents which lead to extended downtimes, special treatment, handling and disposal problems, as well as extensive ecological concerns.
4. **Thorough Cleaning** — High velocity jet streams of water up to 10,000 psi reach into previously inaccessible areas. The system removes all deposits on the interior walls, reaching behind baffles, coils, and agitator blades.
5. **Convenience** — The 3-D nozzle can easily be inserted through the manway opening and extended to the required cleaning positions within the vessel. All lance positioning is controlled from outside the vessel.
6. **Time Savings** — The 3-D nozzle may be inserted into the tank immediately after a batch has been removed, without costly cool-down or air-purging time required for manual cleaning.

Depending on the number of tanks and frequency of cleaning, the cumulative time saved over a given period can be considerable. The hours saved by the short downtime for each cleaning become production time with increased efficiency. And the effectiveness of the cleaning itself improves quality control and efficiency of your process.

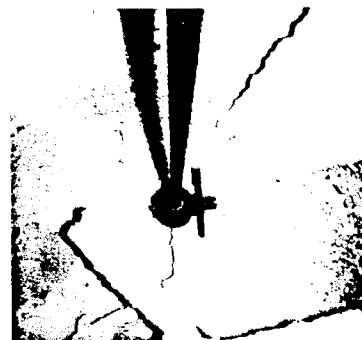
Results from actual tank cleaning operation:



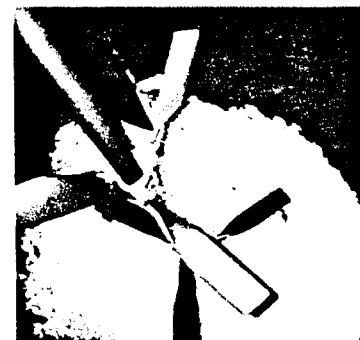
Latex adhesive reactor before cleaning



Latex adhesive reactor after less than 40 minutes cleaning



3,000 gallon latex reactor with NLB nozzle in position before cleaning



3,000 gallon latex reactor with product draining after less than 30 minutes cleaning

### REACTOR AND TANK CLEANING TIME COMPARISON

Reactor Capacity	Present Method: Manual or Chemical	NLB	Present Method	NLB	Production Time	Personnel Costs
3,000 gallons	14 Hours (Manual)	3 Hours	14 Hrs. x 3 Workers = 42 Hours	3 Hrs. x 2 Workers = 6 Hours	11 Hrs.	36 Hrs.
6,000 gallons	28 Hours (Chemical)	4 Hours		4 Hrs. x 2 Workers = 8 Hours	24 Hrs.	+8 Hrs.
50,000 gallons	72 Hours (Manual)	8 Hours	72 Hrs. x 4 Workers = 288 Hours	8 Hrs. x 2 Workers = 16 Hours	64 Hrs.	272 Hrs.

(Times based on NLB systems currently installed)

Front cover illustrations:

Top left - Spray dryer cleaning

Top right - Stripping column cleaning

Bottom right - Rail tanker cleaning

Bottom left - Reactor cleaning

Center - NLB model 10250E pumping unit

**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

DATE 2-21-98

TIME 11:00 AM

RECORD OF TELEPHONE CONVERSATION

PAGE 1 OF 1

FROM: <u>MYRON SCHULTZ</u>	TO: <u>CHUCK ALLEN</u> <sup>LIVONIA</sup> <sub>MISSOURI</sub>
COMPANY: <u>UE &amp; C</u>	COMPANY: <u>AUTOMATED HYDRO SYSTEMS, I.</u>
PHONE: <u>303-843-2454</u>	PHONE: <u>313-772-9696</u>
REFERENCE/PROJECT NO.: <u>6299.001 NREL</u>	
SUBJECT: <u>FERMENTING / DIGESTER TANKS - TANK C.I.P. SYSTEM</u>	

TOPICS OF CONVERSATION:

(NO ONE AVAILABLE TO TALK TO - WILL CALL BACK.)

CHUCK SAID THEY CAN DEVELOP A SYSTEM TO CLEAN THE TANKS AND FLUSH THE ~~SOLIDS~~ SOLIDS OUT, BUT WE WOULD HAVE TO DEFINE THE TYPE OF CLEANING WE WANT TO DO, HOW MANY TANKS AT A TIME, WHETHER WE WANT IT AUTOMATED, & ETC. (GENERAL PROCESS CONDITIONS)

HE SAID GETTING THE SOLIDS OUT, ONCE THEY ARE WASHED DOWN TO THE FLOOR WOULD BE THE BIGGEST CHALLENGE.

HE IS SENDING ME ~~AN~~ INFORMATION ON A SYSTEM THEY ARE PRESENTLY DESIGNING, & WILL SEND ME SOME INFO ON HIS COMPANY'S CAPABILITIES TO DESIGN SYSTEMS.

**AUTOMATED**  
**HYDRO SYSTEMS, INC.**  
HIGH PRESSURE WATER SYSTEMS

27930 Groesbeck  
Roseville, Michigan 48066  
(313) 772-9696 • Fax: (313) 771-1882

---

February 24, 1992

United Engineers Construction  
P.O. Box 5888  
Denver, CO 81217

Attention: Mr. Myron Schultz

Dear Myron:

It was a pleasure talking with you.

You have a very interesting and challenging application to deal with. Automated Hydro Systems specializes in the design and build of high pressure water systems for industry. We have been involved with various tank, reactor cleaning systems and look forward to working with you on this project.

Your challenge is cleaning vessels with such large diameters. Certainly not impossible, simply putting our existing technology where needed to accomplish the goal. We can accomplish this even in the largest vessel.

Factors to be considered:

1. Size of the vessels.
2. Hitting distance.
3. Water wash.
4. Rinse - Sodium Hydroxide (Chemical Data).
5. Sterilize Solution (Chemical Data).
6. Material free flow (Slurry).
7. Sealed system - automatic.

Initially, these are all the know considerations, but more may become obvious as we get further into this project.

I am enclosing two sets of literature along with a drawing of a small monsanto vessel for your information.

Page 2  
02/24/92

After you have reviewed this material, I'll call to discuss this further. If you have any questions, please call at your convenience.

Best Regards,  
Automated Hydro Systems

*Chuck Allen - krs*

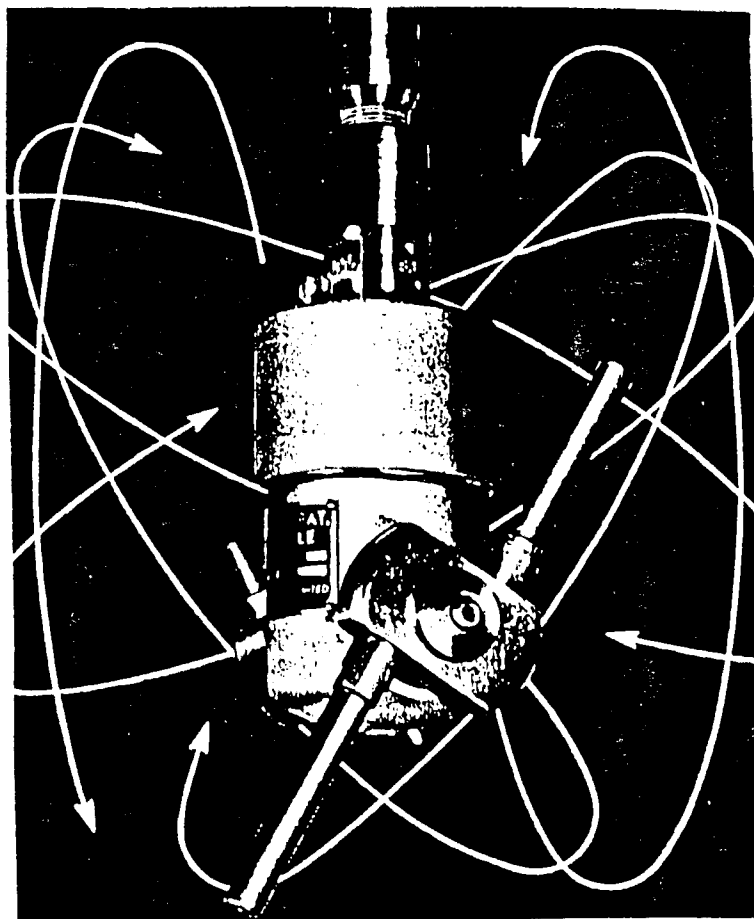
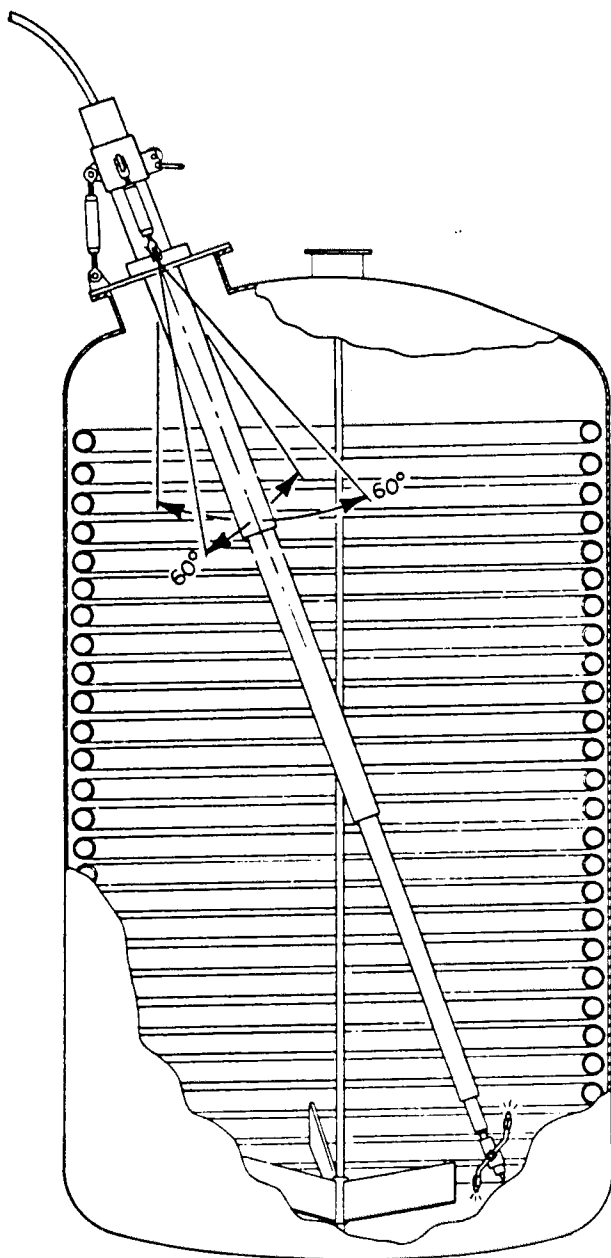
Chuck Allen  
President

# Water Blaster® Accessories

## Vessel and Cleaning Equipment

### Teleboom

Model Number	Number of Sections	Collapsed Length (ft.)	Overall Length (ft.)	Weight (lbs.)	Extended Length (End of Telescope to Flange)
412654-001	3	4.5	11.0	110.0	8' 6"
412654-002	3	6.6	17.0	120.0	14' 6"
412654-003	3	8.5	23.0	130.0	20' 6"



**AUTOMATED**  
**HYDRO SYSTEMS, INC.**  
HIGH PRESSURE WATER SYSTEMS

27930 Groesbeck  
Roseville, Michigan 48066  
(313) 772-9696 • Fax: (313) 771-1882

313-772-9656

PHONE: (313) 462-2820  
FAX: (313) 464-2924

# AUTOMATED HYDRO SYSTEMS, INC.

HIGH PRESSURE WATER SYSTEMS

19852 BAGGERTY ROAD  
LIVONIA, MICHIGAN 48152

## — PAINT TOTES —

Automated Hydro Systems (AHS) will give your paint tote cleaning problem a solution:

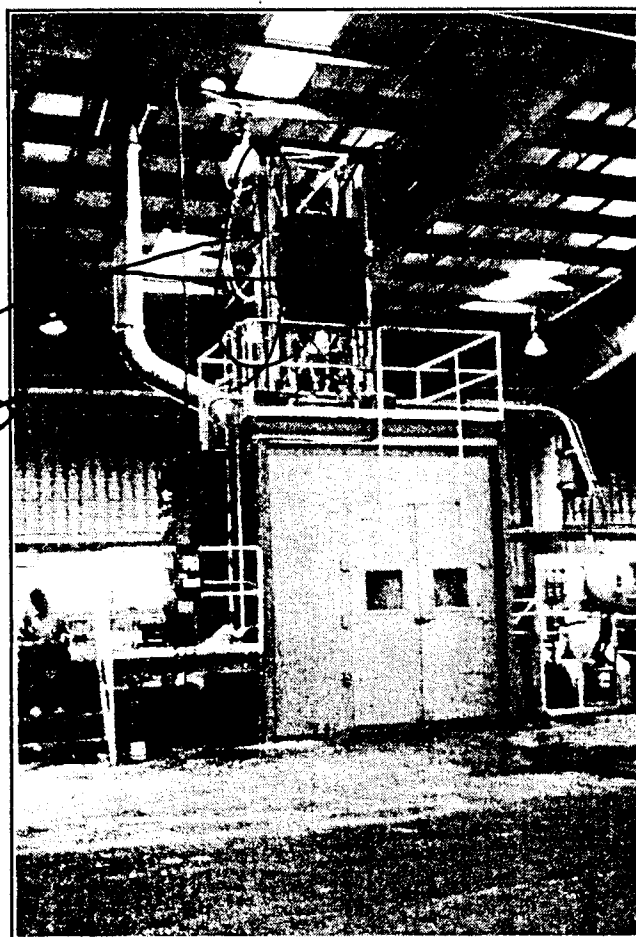
AHS specializes in turn key systems with the full service to support your operation.

### Your Needs

- A Clean Vessel
- Eliminate Vessel Entry
- Eliminate Hazardous Atmosphere
- Minimize Hazardous Waste
- Reduce Labor
- Cost Effective

*2 Telescopic  
booms with rotating  
nozzles for inside and  
outside cleaning of the  
vessels.*

- Experienced
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- Improved Work Atmosphere
- Minimized Hazardous Waste
- Less Labor
- Cost Effective



Let AHS provide you with the best cost effective solution for your paint tote problems.

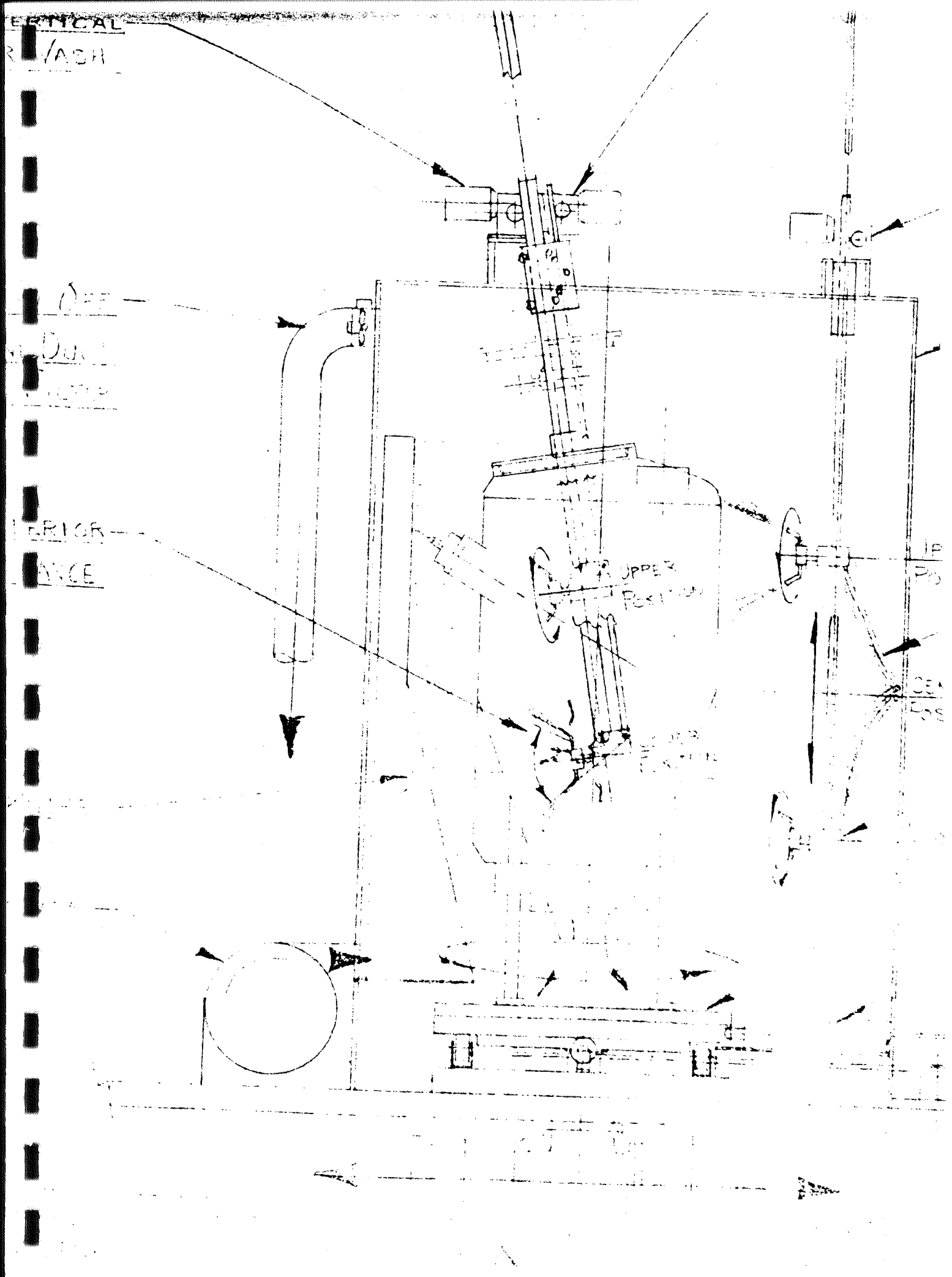
### AHS provides:

- Engineering
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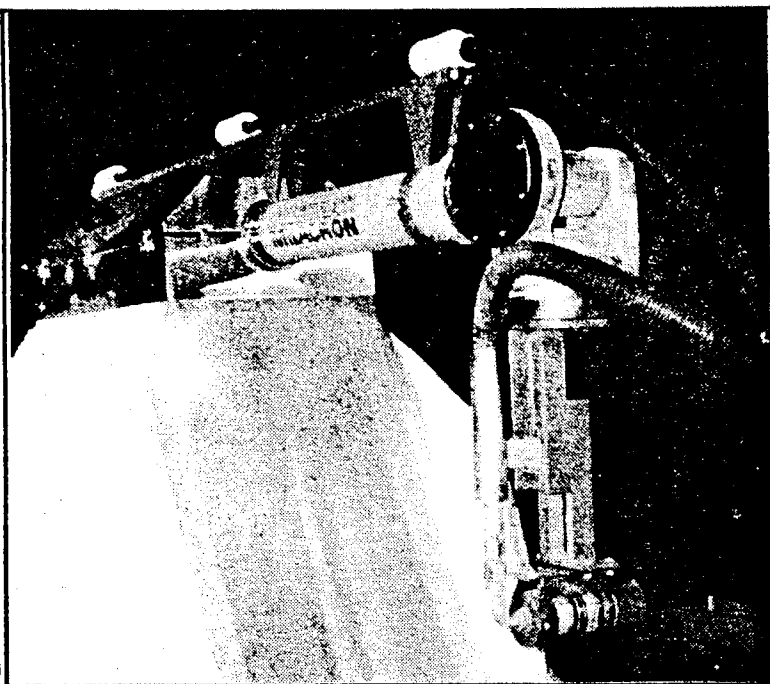
# **AUTOMATED HYDRO SYSTEMS, INC.**

**HIGH PRESSURE WATER SYSTEMS**

PHONE: (313) 772-9696  
FAX: (313) 771-1882

27930 GROESBECK HWY.  
ROSEVILLE, MI 48066

## **PAINT STRIPPING**

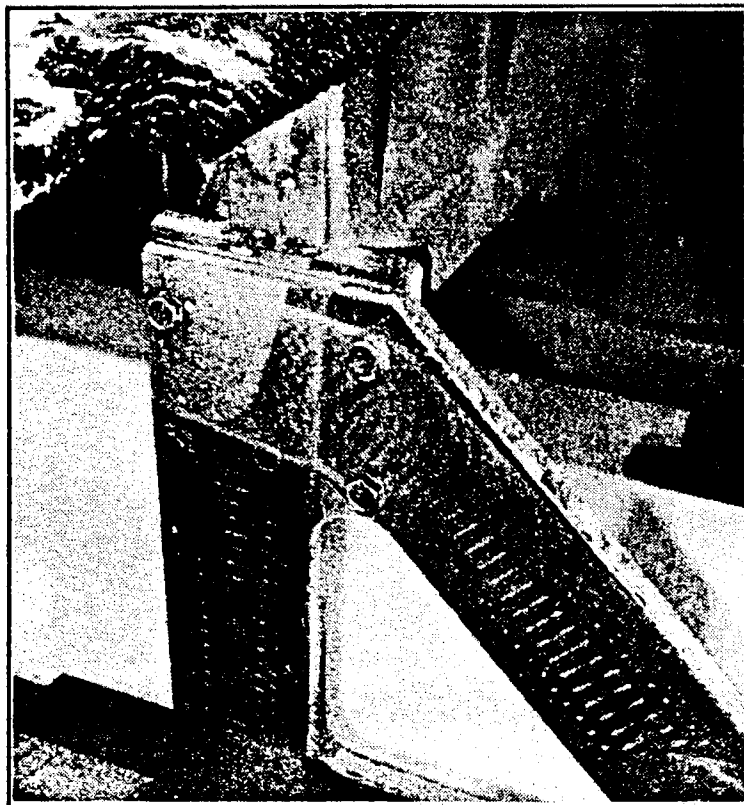


- Body Carrier Cleaning
- Bumper Carrier Cleaning
- Body Wash
- Leak Test
- Paint Booth Grate Cleaning

### ***PICTURED:***

#### **Carrier Cleaning**

- One AHS Model 200-20ES High Pressure Pump
- One Cincinnati Robot
- 20,000 PSI
- Cleaning Time is 15 minutes per carrier.



### ***Available Standard Equipment:***

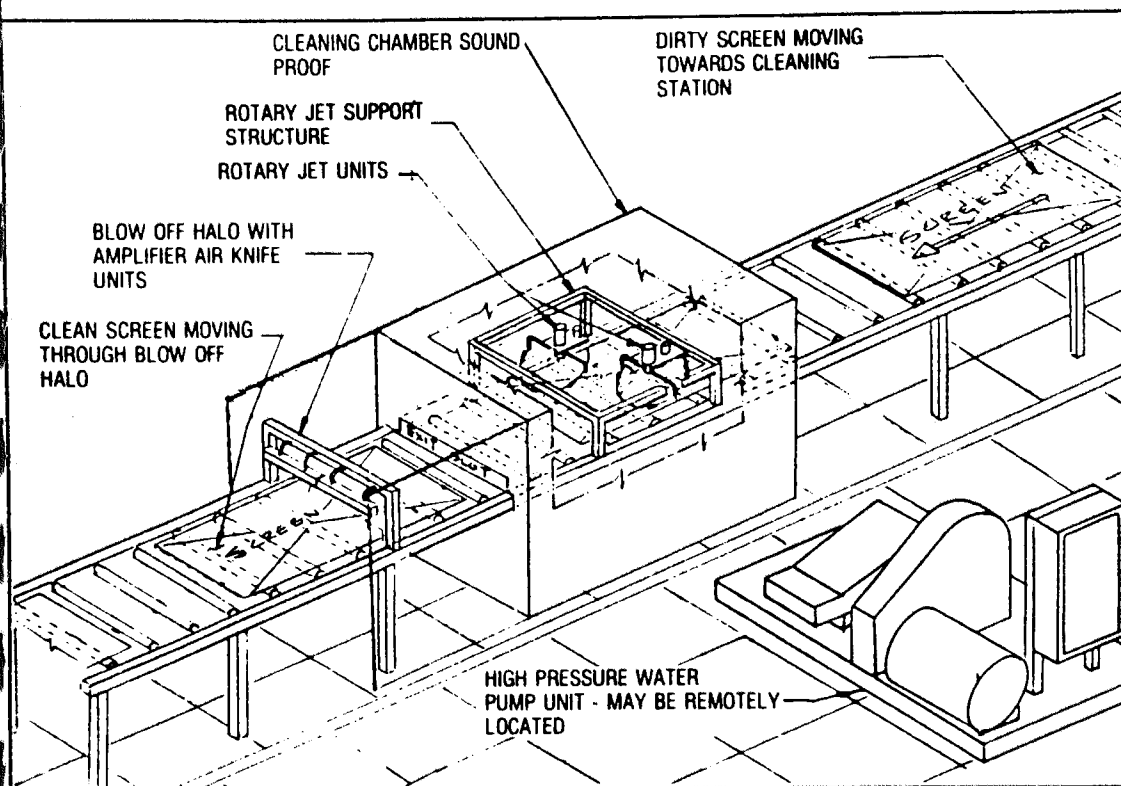
- Pressures up to 60,000 PSI
- Abrasive Cutting Systems
- Wet Sand Blasting Systems
- Guns
- Hose
- Nozzles

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Turnkey Systems*



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Environmental  
Solutions  
for Industry.

*Give us  
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we have the  
solutions!*

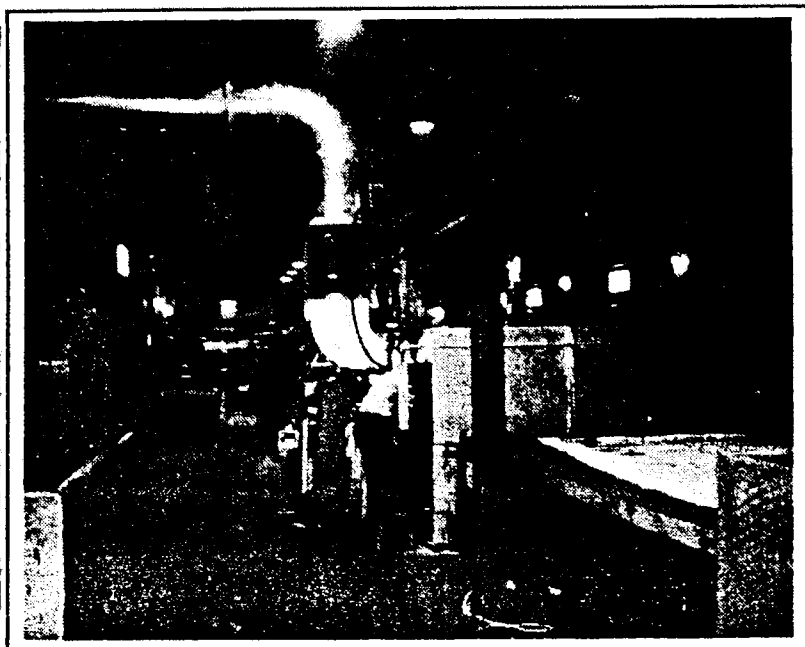
***Clean your screens and plates cost effectively!***

## **ELIMINATE:**

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- Environmental Problems

## **INCREASE:**

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## **AHS Offers:**

- A Proven System
- Complete Turnkey Systems.

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**HIGH PRESSURE WATER SYSTEMS**

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FAX: (313) 771-1882

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ROSEVILLE, MI 48066

## **PAINT CONVEYOR CHAIN, HANGER CLEANING SYSTEM**



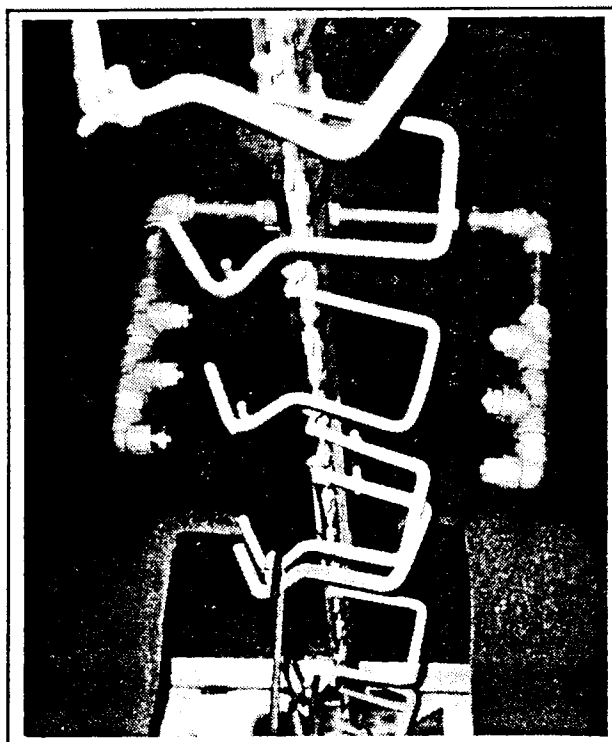
**AHS Standard Systems  
range in pressure from  
3000 to 35,000 PSI.**

### **PROBLEM:**

- Paint Overspray Build-up
- Dirt Build-up

### **SOLUTION:**

- AHS Chain Hanger  
Cleaning System
- High Pressure Pump
- Rotating Jet Seal  
Assembly or -
- High Pressure Fixed  
Manifold to Meet  
Your needs.



### **RESULTS:**

- Reduce contaminated parts by as  
much as 50%.

AHS will design, build and install a  
system to meet your needs.

**QUALITY  
STARTS  
HERE!**



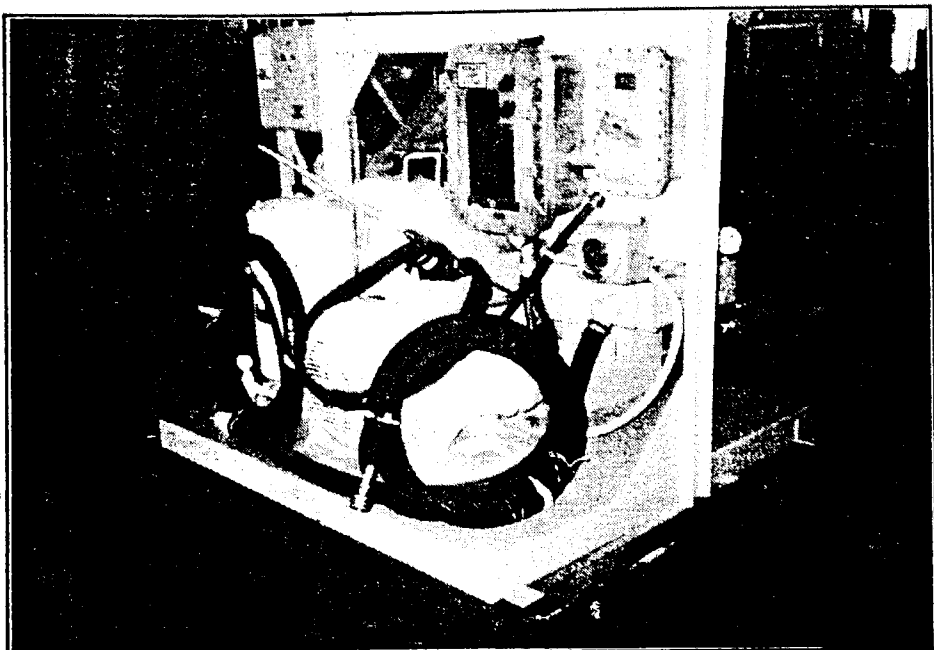
# **AUTOMATED HYDRO SYSTEMS, INC.**

**HIGH PRESSURE WATER SYSTEMS**

PHONE: (313) 462-2820  
FAX: (313) 464-2924

19852 HAGGERTY ROAD  
LIVONIA, MICHIGAN 48152

## **HIGH PRESSURE PUMPS TO 20,000 PSI**



**AHS Standard models range  
from 15 Horsepower to 500  
Horsepower**

***Standard Models  
available in:***

**— Power —**

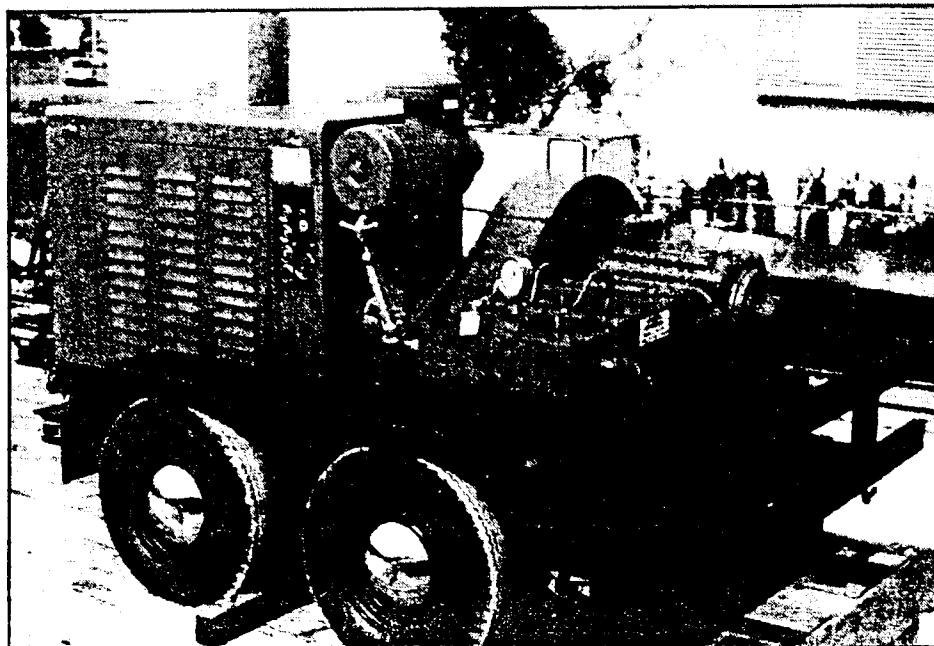
- Electric
- Diesel
- Gasoline
- Propane

**— Mount —**

- Skid
- Trailer
- Dolly Wheels

**— Accessories —**

- Guns
- Hose
- Nozzles



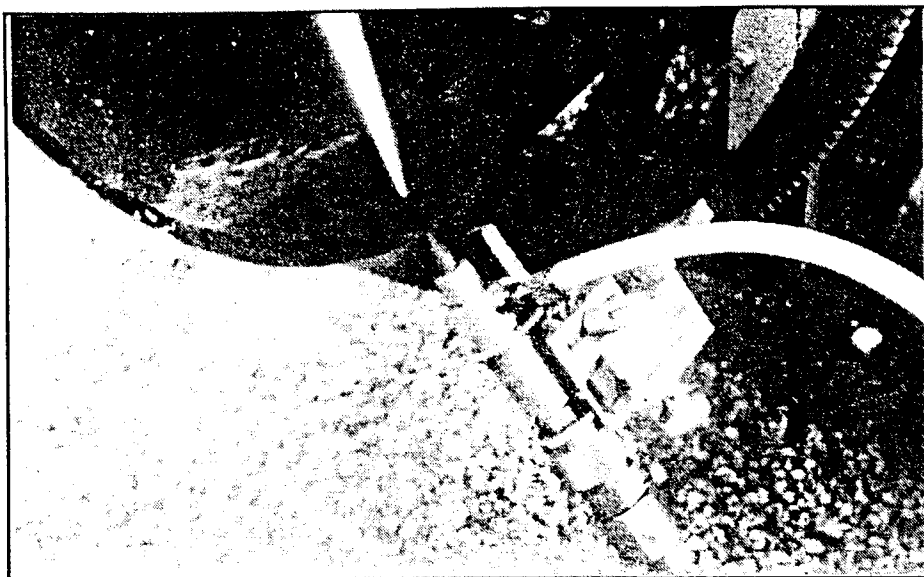
# **AUTOMATED HYDRO SYSTEMS, INC.**

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**HIGH PRESSURE WATER SYSTEMS**

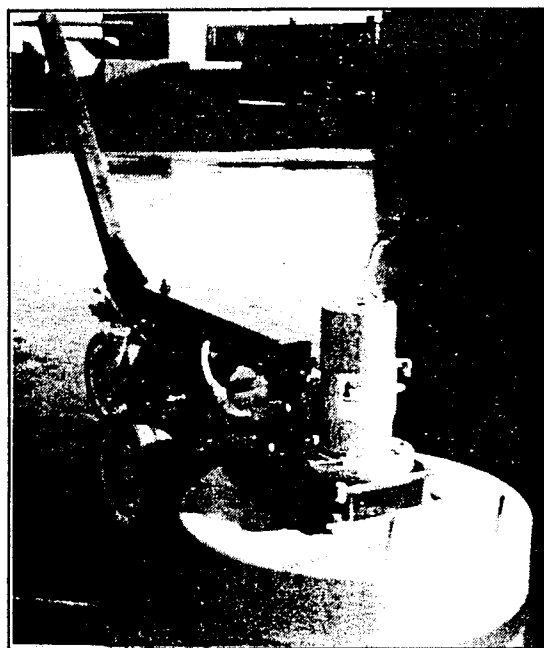
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## **HIGH PRESSURE ACCESSORIES**



### **Abrasive Cutting — Pressures to 60,000 PSI**

- For use with AHS Pumps to 20,000 PSI
- For use with AHS Intensifiers to 60,000 PSI



### **Grate/Floor Cleaner — Pressures to 20,000 PSI**

- Available in 3 or 4 wheel models
- Self propelling Rotating Seal - eliminates need for external power source.

*ATTN: Myron Schwartz*

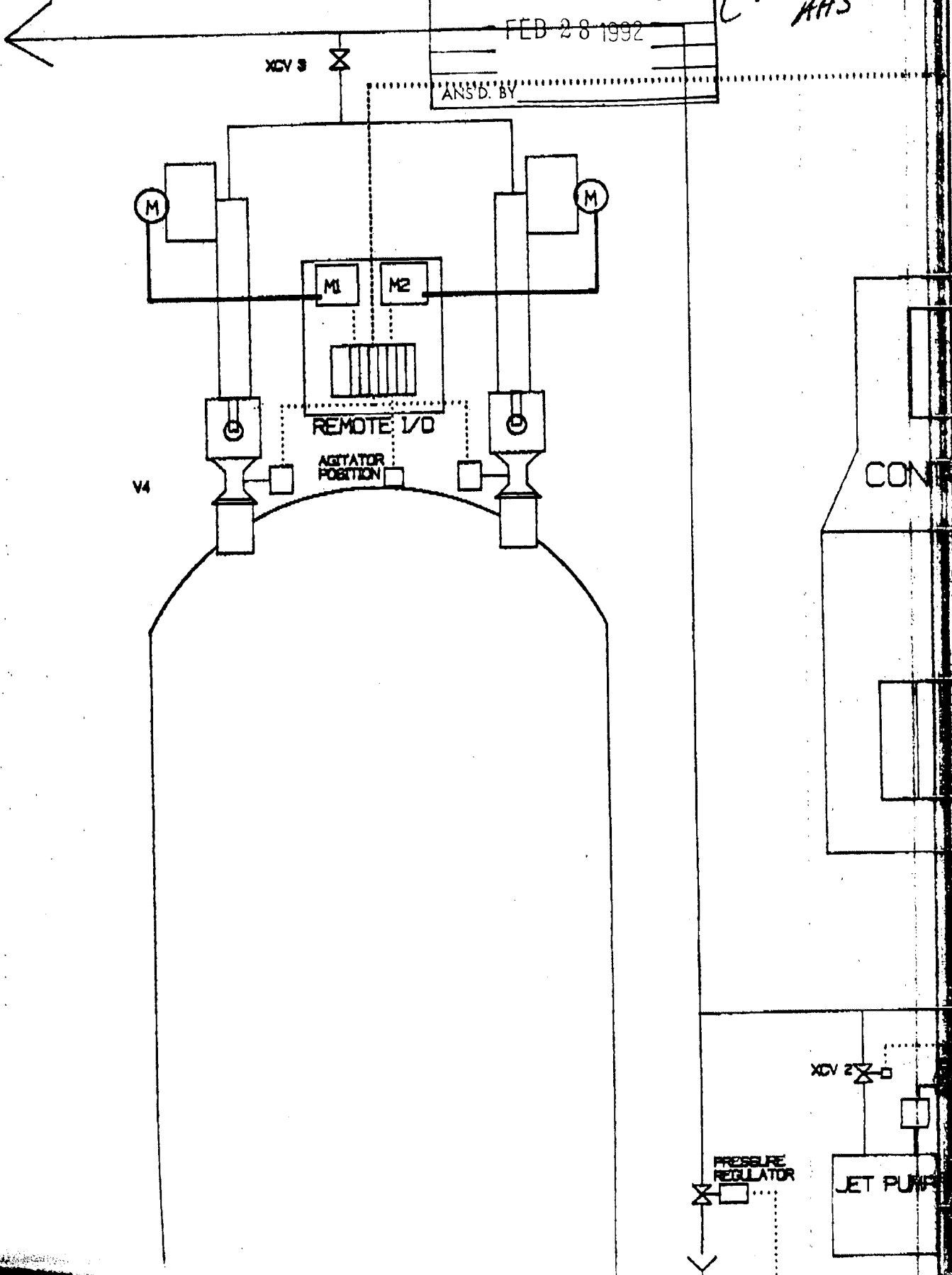
REFER TO MESSAGE NOTED  
SENT

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FEB 28 1992

ANS'D. BY

*Church*  
*HHS*





**Spraying Systems Co.**

**Allison Buhl**

Represented By: **Al Buhl & Associates**  
1600 Broadway - Ste. 2035, Denver, CO 80202  
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**Allison Buhl**

Represented By: **Al Buhl & Associates**  
1600 Broadway - Ste. 2035, Denver, CO 80202  
Tel: 303-830-9002 • FAX: 303-830-9373



**DAN A. WILLIAMS**  
Sales Engineer

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(713) 471-7761  
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FAX: (713) 471-8738  
World Headquarters  
29830 Beck Road  
Wixom, Michigan 48393  
(313) 624-5555  
Facsimile: (313) 624-0908



**TOFTEJORG, Inc.**

**Troy R. Humphries**  
Executive Vice President

2614 East Beltway Eight, Pasadena, Texas 77503 U.S.A.  
Office: (713) 487-7851, Telex: 362102 TOFTE HOU, Fax: (713) 487-7937



**Chuck Allen**  
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**TOFTEJORG, Inc.**

**Jackie L. Heidaker**  
Sales Coordinator

2614 East Beltway Eight, Pasadena, Texas 77503 U.S.A.  
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**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

RECORD OF TELEPHONE CONVERSATION

DATE 2-10-92

TIME 9:00 AM

PAGE 1 OF 1

FROM: MYRON SCHULTZ TO: NIAGARA NATIONAL CORP.  
COMPANY: UNITED ENGINEERS AND CONST. COMPANY: " " "  
PHONE: 303-843-2454 PHONE: 1-800-635-8342  
REFERENCE/PROJECT NO.: 6299.001 NREL  
SUBJECT: FERMENTING / DIGESTER TANKS - C.I.P. SYSTEM

TOPICS OF CONVERSATION:

WHAT IS NIAGARA'S EXPERIENCE IN DESIGNING C.I.P. SYSTEMS FOR LARGE TANKS. WOULD NIAGARA CONSIDER QUOTING A SYSTEM FOR A LARGE FERMENTER?

- MOST OF NIAGARA'S EXPERIENCE IS IN THE DESIGN OF SYSTEMS FOR TRANSPORT TANKERS, HOWEVER THEY COULD DESIGN A CLEANING SYSTEM FOR LARGE FERMENTING TANKS; - THEY WOULD REQUIRE PAYMENT FOR DESIGN OF THE SYSTEM, REFUNDABLE IF THE PROJECT IS FUNDED & THE SYSTEM PURCHASED. ENGINEERING COSTS (DETAIL) WOULD AMOUNT TO \$250,000.

**United Engineers  
& Constructors**

A Raytheon Company

Stearns-Roger Division

RECORD OF TELEPHONE CONVERSATION

DATE 2-10-92

TIME 9:40 AM

PAGE 1 OF 1

FROM: MYRON SCHULTZ TO: JACK MAC DOUGALL  
COMPANY: UE & C COMPANY: V.C.M. CORP.  
NEW YORK  
PHONE: 843-2454 PHONE: 718-442-8190  
REFERENCE/PROJECT NO.: 6299.001 NREL  
SUBJECT: FERMENTING / DIGESTER TANKS - NREL  
TANK C.I. P SYSTEMS

TOPICS OF CONVERSATION:

- Does V.C.M. CORP. FURNISH ONLY THE CLEANING MACHINES, OR DO THEY DESIGN THE CLEANING SYSTEM?
- NORMALLY V.C.M. ONLY FURNISHES THE MACHINES, & JACK DOES NOT KNOW OF ANY COMPANIES THAT SPECIALIZE IN C.I.P. SYSTEM DESIGN, EVEN WITH THEIR MACHINES. MOST COMPANIES' NEED ARE VERY SPECIFIC TO A PARTICULAR INDUSTRY & THEY DESIGN THEIR OWN SYSTEMS.
  - THE MAXIMUM SIZE TANK (PRACTICAL MAX), TO BE ABLE TO LIN. THE CLEANING SYSTEM TO ONE MACHINE PER TANK IS 40'
  - CLEANING MACHINES ARE HARD ON LININGS OR COATINGS, PARTICULARLY WITH REGARD TO DEFECTS IN THE COATINGS OR LININGS.
  - JACK SAID THAT AFTER WE DEVELOP A SPEC FOR OUR SYSTEM, WE SHOULD SEND IT TO HIM & HE WILL THEN DECIDE IF HE WANTS TO GET VCM INVOLVED IN THIS PROJECT.
  - MANY OF THEIR MACHINES ARE PRESENTLY IN USE IN THE FERMENTING INDUSTRIES, INCLUDING ETHANOL PRODUCTION IN VARIOUS MID-WEST CO-OPS.
  - HE WILL FORWARD CATALOG INFO.

DISTRIBUTION

FORM 62-20  
REVISED 5/8

**United Engineers  
& Constructors**

A Raytheon Company

Western Operations

DATE 2/21/92

TIME 10<sup>00</sup> a

**RECORD OF TELEPHONE CONVERSATION**

PAGE 1 OF 1

FROM: <u>LARRY ETEL</u>	TO: <u>MR BOB CHARLES - R&amp;D</u>
COMPANY: <u>UE&amp;C</u>	COMPANY: <u>SOLVAY ENZYMES</u>
PHONE: <u>3547</u>	PHONE: <u>1-800-342-2097</u>
REFERENCE/PROJECT NO.: <u>6299.011</u>	
SUBJECT: <u>BIOCIDES/STERILIZERS FOR FERMENTERS (ETOH)</u>	

**TOPICS OF CONVERSATION:**

WHAT BIOCIDES OR STERILIZING SOLUTIONS ARE AVAILABLE FOR  
SUGAR TO ETHANOL FERMENTATION SYSTEMS ?

1. SOLVAY DOES NOT SELL BIOCIDES, JUST ENZYMES.

2. NORMALLY USE DILUTE CAUSTIC (2-3 % NaOH), HEATED  
TO ABOUT 150°F, TREATING TIME IS ABOUT 30 MINUTES.

3. BOB WILL ASK AROUND HIS LAB TO SEE IF OTHER COMMERCIAL  
BIOCIDES ARE AVAILABLE/USED.

DISTRIBUTION MYRON SCHULTZ  
RAN CLAUSSEN

**United Engineers  
& Constructors**

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Western Operations

DATE 2/21/90TIME 10:00a

## RECORD OF TELEPHONE CONVERSATION

PAGE 1 OF 1

FROM: <u>LARRY EITEL</u>	TO: <u>DAVE KELSO / BECKY (QA LAB DIR)</u>
COMPANY: <u>UE&amp;C</u>	COMPANY: <u>ALTECH</u>
PHONE: <u>3547</u>	PHONE: <u>606-885-9613</u>
REFERENCE/PROJECT NO.: <u>6299.001 - NREL FERMENTER</u>	
SUBJECT: <u>BIOCIDES / STERILIZERS FOR FERMENTERS (ETOH)</u>	

## TOPICS OF CONVERSATION:

WHAT BIOCIDES DOES ALTECH SELL OR USE TO STERILIZE  
FERMENTERS?

1. DILUTE NaOH (2-3%) ~ 150°F, 30 MINUTES IS TYPICAL

2. ALTECH SELLS "CHLORTECH" SOLUTION FOR FERMENTER  
STERILIZATION VIA C.I.P. SYSTEMS. BECKY WILL SEND  
ME LITERATURE & HAVE DAVE KELSO CALL ON FOLLOWUP  
(HE IS SALESMAN). "CHLORTECH" IS CHLORINE DIOXIDE

*Jerry*

DISTRIBUTION

MYRON SCHULTZ  
RON CHASSON

FORM 62-20  
REVISED 5/81



"Where biotechnology, quality, and service meet."

Larry Eitel  
Product Manager  
United Engineers and Constructors  
P.O. BOX 5888  
Denver, CO 80217

Dear Mr Eitel,

It was nice speaking with you today. I have enclosed information on Chlortech. If you have any questions, please feel free to call me. I have also given this information to Dave Kelsall, our salesman for your area. He should be giving you a call.

Sincerely,

A handwritten signature in cursive script that reads 'Becky Timmons'.

Becky Timmons  
Director of Q.A.  
0950X/BT

## USING CHLORTECH TO SANITIZE LINES OVER THE WEEKEND IN A BREWERY

### PRODUCT APPLICATION REPORT

**COORDINATOR:** Mark Phipps, Resident Brewmaster  
Howard Wright, ALLTECH

**LOCATION:** Hudepohl-Schoenling Brewing Company  
Cincinnati, Ohio

**DATE:** Evaluation of product for one year (1989)

**METHODS:** CHLORTECH is used to sanitize beer hoses and lines over the weekend. Preparation is as follows: On Friday following C.I.P. cleaning and subsequent acid cleaning (with SCALE-BITE), CHLORTECH at 100 ppm (activated) fills the lines to stand over the weekend.

**RESULTS:** Counts of bacteria and yeast on Monday morning were zero. Additionally, no corrosion was evident after one year of product use.

# CHLORTECH

CHLORTECH is already cleared by FDA, EPA & USDA for many applications. Some of these are listed below:

- EPA**
- ✓ For sanitizing rinse of uncut, unpeeled fruits and vegetables at 5 ppm followed by potable water rinse.
  - ✓ For dental pumice disinfectants at 500 ppm.
  - ✓ For disinfection of water systems aboard planes, boats, and etc. at 500 ppm. Up to 500 ppm for clean non-porous surfaces.
  - ✓ For treatment of stored potable drinking water at 5 ppm.
  - ✓ For disinfection and deodorization of animal confinement units at 500 ppm.

- FDA**
- ✓ In 21 CFR 178.1010 cleared by FDA for all food contact surfaces at maximum 200 ppm. Actual use concentration is 100 ppm.

- USDA**
- ✓ For bacterial and mold control in federally inspected meat and poultry processing surfaces section P1 at 500 ppm.
  - ✓ D2 approval as a terminal sanitizing rinse not requiring water flush on all food contact surfaces in food processing plants at 100 ppm.

## Comparison with other disinfectants

A recent study from the University of Oklahoma (Turner, 1988) compared the levels of disinfectants required to achieve a 99.999% kill in 60 seconds of various microorganisms. The results are shown below:

### Level of Disinfectants to Achieve a 99.999% Kill

Disinfectant (mg/liter)	Microorganism:		
	Pseudomonas aeruginosa	Staphylococcus aureus	Saccharomyces cerevisiae
Chlorine compound I (Chlorox)	1,000	1,000	1,000
Chlorine compound II (Sodium Chlorine)	820	820	1,000
Stabilized Chlorine Dioxide I	310	1,300	640
Stabilized Chlorine Dioxide II (CHLORTECH)	48	93	95
Iodophor	440	440	450
Peroxide	36,000	68,000	270,000
Glutaraldehyde-phenol	2,300	1,200	620
Acid glutaraldehyde	6,600	2,200	18,000
Quaternary	580	140	740
Acidified quaternary	150	1,200	300
Phenolic	1,500	380	190

#### CONCLUSION:

CHLORTECH was most the effective disinfectant and gave a 99.999% kill at 50-100 ppm in 60 seconds. It was 50-100 times more effective than sodium chlorine.

## DIRECTIONS FOR USE

1. Poultry Processing Plants: As an additive to potable water, process water systems and ice made from potable water to inhibit bacterial slime and improve taste and odor, use concentrations up to 2.0 gallons of CHLORTECH per 1,000 gallons of water (40 ppm ClO<sub>2</sub>).
2. Meat Processing Plants: As an additive to potable water, process water systems and ice made from potable water to inhibit slime and improve taste and odor, use concentrations of up to 0.5 gallons of CHLORTECH per 1,000 gallons of water (10 ppm ClO<sub>2</sub>).
3. For sanitizing and odor control: Treat walls, floors, drains, cutting surfaces, utensils, equipment, holding tanks, receiving tanks and pipe lines. Treat with a 1:50 dilution (2.5 oz. per gallon) solution (400 ppm ClO<sub>2</sub>) which has been adjusted to pH of approximately 4-5 prior to use employing citric acid. Allow to soak for 20 minutes. Flush with potable water before reuse.
4. Dairy and Beverage Plants: For bacteria control of lines and fillers during downtimes, fill lines and filler with a solution of 150 ppm ClO<sub>2</sub> which has been adjusted to a pH of 4-5 with citric acid. Let stand for downtime. Flush with potable water before reuse.
5. For mold inhibition on floors, walls, and ceilings, fog with concentration of CHLORTECH up to 2,500 ppm ClO<sub>2</sub>.

DILUTION TABLE:		
GALLONS CHLORTECH	GALLONS WATER	PPM ClO <sub>2</sub>
1	20,000	1.0
1	2,000	10.0
1	1,000	20.0
1	500	40.0
1	400	50.0
1	250	80.0
1	200	100.0
1	50	400.0
1	7	2,500.0

#### PROPERTIES:

Form: Clear liquid  
 Color: Pale yellow  
 Odor: Mild  
 Density: 8.8 lbs./gal.  
 Freezing Point: 11°F  
 pH: 8.6 as is  
 Shelf Life: Exceeds 18 months  
 Metal Safety: Safe in all metals, glass and plastic in normal use concentrations.



"Where biotechnology, quality, and service meet."

## CHLORTECH

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0541X

## CHLORTECH

CHLORINE DIOXIDE FROM ALLTECH, INC.

APPLICATIONS AND DIRECTIONS FOR USE

### A. IN FOOD PROCESSING PLANTS SUCH AS POULTRY, FISH AND MEAT AND IN RESTAURANTS, DAIRIES, BOTTLING PLANTS AND BREWERIES.

1. AS A TERMINAL SANITIZING RINSE FOR STAINLESS STEEL AND OTHER HARD NON-POROUS FOOD CONTACT SURFACES SUCH AS TANKS, TRANSFER LINES AND FOOD PROCESSING EQUIPMENT.
  - a. All gross food particles and soil should be removed prior to sanitizing by use of a pre-flush, pre-scrape or pre-soak treatment.
  - b. Clean tank, line or surface thoroughly using a good detergent and rinse with clean potable water before sanitizing.
  - c. Preparation of sanitizing solution: Place 3.25 fl oz of CHLORTECH into a clean plastic pail or container and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area. Avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time for crystals to dissolve completely. To this solution, add 5 gallons of clean potable water. This will yield a working solution containing 100 ppm available chlorine dioxide.
  - d. To apply, fill, flush, immerse or spray tank, line, equipment or food contact surface with active solution making sure surface area is thoroughly wet for at least one minute. After sanitizing, drain tank, line or equipment and allow to air dry. Fresh sanitizing solution should be made up daily or more often if solution becomes diluted or soiled.

2. TO DISINFECT WALLS, CEILINGS AND FLOORS.

- a. Before disinfection, all gross filth must be removed from areas to be disinfected and thoroughly cleaned with a good detergent followed by a clean, potable water rinse.
- b. Preparation of active disinfection solution: Place 3.25 fl oz of CHLORTECH per gallon of working solution (500 ppm available  $\text{ClO}$ ) into a clean, plastic pail and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. To this solution, add one gallon of clean, potable water. This will yield a working solution containing 500 ppm of available chlorine dioxide.
- c. To apply, spray or fog disinfectant solution onto surface to be disinfected, using a suitable spraying or fogging device and making sure that the area is thoroughly wet for at least ten minutes. Active solutions may be irritating when breathed, therefore, always use a suitable protective breathing apparatus when fogging or spraying these solutions. After application, allow to air dry. Treat as required. Always apply freshly made solutions. Never reuse activated solutions.

3. TO CONTROL THE BUILDUP OF ODOR AND SLIME-FORMING BACTERIA IN PROCESS WATERS FOR VEGETABLE RINSES AND ASSOCIATED TANKS, FLUMES AND LINES.

- a. All tanks, flumes, etc., should be thoroughly cleaned when possible with a good detergent and completely rinsed using clean, potable water prior to treatment.
- b. Preparation of solution: Chill tanks or vegetable rinse tanks may be batch loaded at start up with 1.3 fl oz (10ml) CHLORTECH per ten gallons of potable water (5.0 ppm available  $\text{ClO}_2$ ). Make up water should be treated using a chemical feed pump or injector system and applied at the rate of 1.3 fl oz per ten gallons potable water. Make up new CHLORTECH solution daily.

Optional activated solution - if heavy use of rinse water is expected or if slime buildup is extreme, an additional activation step may be used in preparation of solution.

- c. Preparation of activated solution: Prepare in a well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. For each ten gallons of rinse water to be used, measure out 1.3 fl oz (10ml) of CHLORTECH and pour into a clean plastic container, pail or drum. To this CHLORTECH amount, add citric acid of no less than 99% purity, at the rate of 1/4 teaspoon crystals ( 1 gram) per 1/3 fl oz CHLORTECH.

Allow 5 minutes reaction time for crystals to dissolve. Chill tanks or vegetable rinse tanks may be batch loaded at start up with activated CHLORTECH solution with 1/3 fl oz (10ml) per ten gallons of potable water (5.0 ppm available  $\text{ClO}_2$ ). Make up water should be treated using a chemical feed pump. In order to ensure accurate delivery, a 1 to 10 dilution of the active concentrate should be made and the feed rate of 3-1/3 fl oz per 10 gallons should be maintained. Make up fresh CHLORTECH solutions daily.

NOTE: Chemical feed pumps and injectors must be chlorine resistant for best operation. Available  $\text{ClO}_2$  levels should be confirmed.

4. FOR USE IN THE PREPARATION OF FRUITS AND VEGETABLES TO EXTEND FRESHNESS AND SHELF LIFE.

- a. Before treatment, whole fruits and vegetables should be washed and thoroughly rinsed with clean potable water.

PRE-TREATMENT FOR UNCUT, UNPEELED FRUITS AND VEGETABLES.

- b. Preparation of treatment solution: Measure 0.032 fl oz of CHLORTECH per gallon of treatment water. This gives a use solution concentration of 5 ppm.

- c. Dip produce in treatment solution for about 10 to 20 seconds, then follow with a potable water rinse.

POTABLE WATER RINSE FOR CUT AND PEELED FRUIT AND VEGETABLES.

- d. Use 0.0064 fl oz of activated CHLORTECH per gallon of rinse water. This gives a use solution concentration of 1 ppm.

- e. Rinse produce in sink for about 10 to 20 seconds. For a more thorough rinse break produce apart.

5. TO CONTROL THE BUILDUP OF ODOR AND SLIME-FORMING BACTERIA IN ICE MAKING PLANTS AND MACHINERY.
  - a. Ice Making machinery should be disassembled and thoroughly cleaned using a good detergent followed by a potable water rinse.
  - b. Preparation and application of solution: The CHLORTECH solution should be applied to the incoming water line of the ice machine via a chemical feed pump or injector system and proportioned at the rate of 1.5 fl oz per ten gallons potable water (20 ppm available  $\text{ClO}_2$ ).
6. TO CONTROL ODOR AND SLIME-FORMING BACTERIA BUILDUP IN COMMERCIAL WATER FILTRATION SYSTEMS, SAND BEDS, GRAVEL BEDS AND CHARCOAL FILTERS WITH ACCESSIBLE SERVICE HATCHES.
  - a. Drain all existing water from sand and carbon filters and rinse once with clean, potable water. Fill sand filter with potable water and adjust pH of water to 6.0 using citric acid or equivalent pH adjuster.
  - b. To prepare solution: Measure out 2 fl oz CHLORTECH concentrate for each gallon of filter system volume (300 ppm available  $\text{ClO}_2$ ) and add to the sand filter through access hatch. Fill system with clean, potable water and circulate system 30 minutes. Allow system to soak 2 to 3 hours. After treatment, drain system and rinse with clean, potable water until residue is no longer detectable and when pH is normal.
7. TO CONTROL MOLD AND MILDEW, ODOR AND SLIME-FORMING BACTERIA ON WALLS, FLOORS AND CEILINGS.
  - a. Before treatment, all soil and gross filth must be removed from areas to be treated and cleaned with detergent followed by a potable water rinse.
  - b. Preparation of solution: Place 6 1/2 fl oz of CHLORTECH concentrate per gallon of working solution (1,000 ppm available  $\text{ClO}_2$ ) into a clean, plastic pail or drum and dilute with clean, potable water.
  - c. To apply, spray or fog solutions onto walls, floors and ceilings using a suitable spraying or fogging device and making sure all surface areas are damp. Avoid breathing solution mists by use of a suitable protective breathing apparatus. Avoid contact with food or food contact surfaces. Allow to air dry.
  - d. Repeat application as needed.

8. TO CONTROL THE BUILDUP OF ODOR AND SLIME-FORMING BACTERIA IN STAINLESS STEEL TRANSFER LINES AND ON-LINE EQUIPMENT SUCH AS HYDROCOOLERS, PASTEURIZERS, ETC., OVERNIGHT AND OVER WEEKENDS.

- a. Clean equipment or line thoroughly using a good detergent followed by a clean, potable water rinse before treatment.
- b. Preparation and application of solution: For each ten gallons of volume in lines and/or equipment, add 1 1/4 fl oz of CHLORTECH (20 ppm available  $\text{ClO}_2$ ) to potable make up water. Mix and fill lines and equipment overnight. Drain and allow to air dry just prior to next run startup.

## B. IN LABORATORIES, HOSPITALS MORGUES, INSTITUTIONS

1. TO DISINFECT NON-POROUS, HARD SURFACES SUCH AS TILE FLOORS, WALLS AND CEILINGS, STAINLESS STEEL COLD ROOMS AND WALK IN INCUBATORS.
  - a. Clean all surfaces thoroughly with a good detergent and rinse with water prior to disinfection.
  - b. Preparation of active disinfection solution: Place 3 1/4 fl oz of CHLORTECH concentrate per gallon of working solution (500 ppm available chlorine dioxide) into a clean, plastic pail and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. To this solution add one gallon of clean, potable water. This will yield a working solution containing 500 ppm available chlorine dioxide.
  - c. To apply, activated solutions may be fogged, sprayed, mopped or sponged onto surfaces to be disinfected. All surfaces must be thoroughly wetted for at least ten minutes. When spraying or fogging disinfectant solutions, use a appropriate spraying or fogging device. Active solutions may be irritating when breathed, thereafter, always use a suitable protective breathing apparatus when fogging or spraying these solutions. After application, allow to air dry. Treat as required. Always apply freshly made solutions. Never reuse activated solutions. Cold room temperatures must be at least 20 °C prior to disinfection.
2. TO DISINFECT BENCH TOPS, BIOLOGICAL HOODS, INCUBATORS, STAINLESS STEEL EQUIPMENT AND INSTRUMENTS.
  - a. Clean all surfaces thoroughly with a good detergent and rinse with water prior to disinfection.
  - b. Preparation of active disinfectant solution: Place 25ml of CHLORTECH concentrate for each liter of working solution into a clean, plastic pail or glass beaker and add 2.5 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. Then add activated CHLORTECH solution to one liter of clean, potable water. This will yield a working solution containing 500 ppm available chlorine dioxide.

- c. To apply, activated solutions may be squirted directly onto surfaces from a plastic squeeze bottle or may be used as a soak solution. All contact surfaces must be thoroughly damp for at least ten minutes. Allow to air dry. Activated solutions of CHLORTECH stored in plastic squirt bottles, may be held up to one week before replacement with fresh solution. Soak solutions of CHLORTECH should be changed daily.

### 3. TO DISINFECT WATER BATH INCUBATORS.

- a. Prior to disinfection, thoroughly clean the reservoir with a good detergent and rinse with clean water.
- b. Preparation of active solution: Place 1/3 fl oz of CHLORTECH concentrate per gallon of working solution or 2.5 ml CHLORTECH per liter of working solution into a clean glass or plastic container. (50 ppm available chlorine dioxide) Add one gram of citric acid per each 1/3 fl oz CHLORTECH or 1/4 gram for each 2.5 ml CHLORTECH food grade citric acid of no less than 99% purity. Prepare in a well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. Add activated CHLORTECH solution to one gallon of clean, potable water or 2.5 ml of activated CHLORTECH solution per liter of clean, potable water. This will yield a working solution containing 50 ppm available chlorine dioxide.
- c. To apply, activated solution should be poured into waterbath reservoir and allowed to stand one hour at room temperature. Drain reservoir and fill with fresh water.

### 4. TO CONTROL ODOR AND SLIME FORMING BACTERIA IN WATERBATH INCUBATORS.

- a. When using CHLORTECH in waterbath incubators, always begin with a freshly cleaned and disinfected reservoir.
- b. To apply, fill waterbath with clean, potable water to near capacity. For each gallon of water add 1/3 fl oz CHLORTECH (50 ppm available  $\text{ClO}_2$ ) or 2.5 ml CHLORTECH per liter of water. When water becomes cloudy, discard water and repeat procedure.

5. TO CONTROL ODORS RESULTING FROM THE STERILIZATION OF SPENT BIOLOGICALS IN STEAM AUTOCLAVES.
  - a. To reduce autoclave odors of used biologicals, CHLORTECH should be sprayed or poured directly into the stainless steel autoclave buckets.
  - b. Preparation of solution: Place 6 1/4 fl oz of CHLORTECH concentrate per gallon of working solution (1,000 ppm available  $\text{ClO}_2$ ) or 50.0 ml CHLORTECH per one liter of water into a clean glass or plastic container. Dilute concentrate to one gallon clean, potable water per each 6 1/2 fl oz or to one liter per each 50.0 ml.
  - c. To apply, spray or pour CHLORTECH solution into or onto the autoclave buckets just prior to autoclaving.
6. TO DEODORIZE ANIMAL HOLDING ROOMS, SICK ROOMS, MORGUES AND WORK ROOMS.
  - a. Rooms to be deodorized should be in a clean condition prior to CHLORTECH application.
  - b. Preparation of solution: Place 6 1/2 fl oz CHLORTECH concentrate per one gallon of working solution or 50 ml per one liter working solution (1,000 ppm available chlorine dioxide) into a clean glass or plastic container. Dilute concentrate to one gallon clean, potable water for each 6 1/2 fl oz or to one liter for each 50 ml CHLORTECH.
  - c. To apply, spray or fog solution using a suitable spray or fogging device onto walls, ceilings and floors, lightly dampening all surfaces. Avoid breathing mist of solutions by using a suitable protective breathing apparatus. Allow to air dry, then ventilate the area. Treat as required.

## C. IN ANIMAL REARING AND CONFINEMENT FACILITIES

### 1. TO DISINFECT COMMERCIAL ANIMAL CONFINEMENT FACILITIES SUCH AS POULTRY HOUSES, SWINE PENS, CALF BARNES AND KENNELS.

- a. Remove all animals and feeds from premises, vehicles, enclosures, coops and crates.
- b. Remove all litter and manure from floors, walls and surfaces of barns, pens, stalls, chuted and other facilities and fixtures occupied or traversed by animals.
- c. Empty all troughs, racks and other feeding and watering appliances.
- d. Thoroughly clean all surfaces with soap or detergent and rinse with water.
- e. Preparation of active disinfectant solution: Place 3 1/4 fl oz CHLORTECH concentrate per gallon of working solution (500 ppm available chlorine dioxide) into a clean, plastic pail and add ten food grade citric acid of no less than 99% purity. Prepare in a well ventilated area. Avoid breathing any fumes which may produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. To this solution, add one gallon of clean, potable water. This well yield a working solution containing 500 ppm of available chlorine dioxide.
- f. To apply, using commercial fogger or sprayer, saturate all surfaces with the activated CHLORTECH solution for a period of ten minutes. Active solutions may be irritating when breathed, therefore, always use a suitable protective breathing apparatus when fogging or spraying these solutions. Immerse all halters, ropes and other types of equipment used in handling and restraining animals as well as forks, shovels and scrapers used for removing litter and manure. After treatment, ventilate buildings, coops or other enclosed spaces and allow to air dry. Repopulate when solution has dried. Thoroughly scrub treated feed racks, troughs, automatic feeders, fountains and waterers with soap or detergent and rinse with potable water before use.

### 2. TO CONTROL THE BUILDUP OF ODOR AND SLIME-FORMING BACTERIA IN ANIMAL CONFINEMENT AREAS.

- a. Remove all litter and manure from floors, walls and surfaces of barns, pens, stalls, chutes, cases and other facilities and fixtures occupied or traversed by animals. Thoroughly clean all surfaces with soap or detergent and rinse with clean water.

- b. Preparation of solution: Place 6 1/2 fl oz CHLORTECH concentrate per gallon of working solution (1,000 ppm available  $\text{ClO}_2$ ) into a clean, plastic pail. Dilute concentrate with one gallon clean, potable water for each 6 1/2 fl oz CHLORTECH.
  - c. To apply, using a commercial fogger or sprayer, saturate all surfaces with the CHLORTECH solution. When fogging or spraying CHLORTECH solutions, always use a suitable protective breathing apparatus to avoid breathing mist.
3. TO CONTROL ANIMAL ODORS ON PETS AND IN LITTER BOXES, CARPETS AND CONCRETE FLOORS.

- a. For litter boxes: Wash out litter boxes with good detergent and rinse with clean, potable water. Soak overnight in solution of one oz CHLORTECH per one quart of water (650 ppm available chlorine dioxide). Add litter, sprinkle surface liberally with CHLORTECH solution.
- b. For controlling odors in carpets: Add 3 oz CHLORTECH per gallon (500 ppm available chlorine dioxide) of rug shampoo mix or 3 oz CHLORTECH per each gallon of rinse water. Shampoo carpet. Allow to air dry.

CAUTION: CHLORTECH MAY BLEACH SOME CARPETS AND FABRICS ESPECIALLY IF APPLIED ON TOP OF ANOTHER CHEMICAL AGENT. DO NOT APPLY UNTIL A SAMPLE TEST HAS BEEN TRIED AND OBSERVED FOR AT LEAST 24 HOURS.

- c. For concrete floors: Clean floor thoroughly using a good detergent; rinse with clean water. Prepare solution by adding 8 oz (1250 ppm available chlorine dioxide) CHLORTECH per gallon of water. Mop or spray solution liberally onto floor. Allow to air dry.
- d. For animal baths: Wash animal well with appropriate pet shampoo; rinse with clean water. Prepare solution by adding 1/4 oz CHLORTECH (80 ppm available chlorine dioxide) per gallon of water. Rinse animal thoroughly with prepared solution. Allow to air dry. Avoid direct contact with animal's eyes, nose and ears.
- e. For treating animal odors with high levels of ammonia: Wash area thoroughly with good detergent and rinse with clean water. Preparation of solution: For each gallon of solution, place 4 oz CHLORTECH into a clean, plastic container. To this concentrate add 1 tablespoon household bleach and allow to react for five minutes. Dilute with 1 gallon clean, potable water. Apply by mopping or spraying solution liberally onto area. Allow to air dry. Additional applications may be necessary.

## D. IN WATER TREATMENT AND WATER STORAGE SYSTEMS

### 1. TO DISINFECT WATER STORAGE SYSTEMS ABOARD AIRCRAFT, BOATS, RV'S, OFF-SHORE OIL RIGS, ETC.

- a. Prior to disinfection, tanks should be cleaned using a good detergent and thoroughly flushed with clean, potable water. There is both a ten minute and a one hour disinfection procedure to choose from.
- b. Preparation of active solution: For ten (10) minute procedure: Place 3 1/4 fl oz of CHLORTECH concentrate per gallon of working solution (500 ppm available chlorine dioxide) into a clean plastic container and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area. Avoid breathing any fumes which may be produced while crystals are dissolving completely. Allow five minutes reaction time and for crystals to dissolve completely. Pour activated solution into tank and dilute with clean potable water, filling the tank completely, at the rate of one gallon for each 3 1/4 fl oz CHLORTECH. Bleed air out of lines and allow to stand at least ten minutes. Drain tank and lines and flush with potable water. For one hour procedure: Place 3 1/4 fl oz of CHLORTECH concentrate per ten gallons of working solution (50 ppm available chlorine dioxide) into a clean plastic container and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in a well ventilated area. Avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. Pour activated solution into tank and dilute with clean, potable water, filling the tank completely, at the rate of ten gallon for each 3 1/4 fl oz CHLORTECH. Bleed air out of lines and allow to stand at least one hour. Drain tank and lines and fill with potable water.

### 2. TO CONTROL BUILDUP OF SLIME AND ODOR CAUSING BACTERIA AND ENHANCE THE TASTE OF STORED POTABLE WATER.

- a. Prior to treatment of potable water, thoroughly clean and disinfect the water storage system to ensure a sanitary condition. Thoroughly rinse with clean, potable water.

- b. Potable water should be treated at a rate of one fl oz CHLORTECH per 30 gallons potable water (5 ppm available  $\text{ClO}_2$ ) and may be injected or batch treated.
  - c. Water storage tank should be sufficiently sealed to prevent outside contamination and direct sunlight.
3. TO HELP REMOVE OFF ODORS AND TASTES FROM MUNICIPAL WELL WATERS.
- a. CHLORTECH should be injected into the incoming water main using a chemical proportioning pump or injector at a rate of 1.0 fl oz CHLORTECH per 150 gallons water (1.0 ppm available  $\text{ClO}_2$ ).
  - b. CHLORTECH levels should be checked weekly.

## E. IN INDUSTRIAL APPLICATIONS

1. TO INHIBIT THE GROWTH OF SLIME AND ODOR CAUSING BACTERIA IN WATER BASE CUTTING OILS.
  - a. CHLORTECH may be added directly to water base oils at the rate of 1/3 to 1 1/3 fl oz CHLORTECH per gallon of oil. Mix well.
2. TO DISINFECT HARD SURFACES ASSOCIATED WITH VENTILATION AND AIRY CONDITIONING DUCT WORK.
  - a. Prior to disinfection, duct work should be mechanically cleaned, vacuumed or blown free of dirt, dust, mold and debris, using a commercially available duct cleaning systems, or service.
  - b. Preparation of disinfectant solution: Place 3 1/4 fl oz of CHLORTECH concentrate per gallon of working solution (500 ppm available  $\text{ClO}_2$ ) into a clean, plastic pail and add 10 grams of food grade citric acid of no less than 99% purity. Prepare in well ventilated area, avoid breathing any fumes which may be produced while crystals are dissolving. Allow five minutes reaction time and for crystals to dissolve completely. To this solution, add one gallon of clean, potable water. This will yield a working solution containing 500 ppm of available chlorine dioxide.
  - c. To apply, spray or fog disinfectant solution into duct work to be disinfected, using a suitable spraying or fogging device and make sure that the surfaces are thoroughly wet for at least ten minutes. Active solutions may be irritating when breathed, therefore, always use a suitable protective breathing apparatus when fogging or spraying these solutions. After application, allow to air dry. Treat as required. Always apply freshly made solutions.
3. TO DEODORIZE VENTILATION AND AIR CONDITIONING DUCT WORK SYSTEMS.
  - a. Prior to deodorization, duct work should be mechanically cleaned, vacuumed or blown free of dirt, dust, mold and debris, using a commercially available duct cleaning system, or service.
  - b. Preparation of deodorizing solution: Place 6 1/2 fl oz CHLORTECH concentrate per gallon of working solution, into clean plastic container and dilute with clean water to desired volume.
  - c. To remove musty odors, spray or fog deodorizer thoroughly into duct work or ventilation system. Allow to air dry prior to operating system. Treat as required. For persistent odors, system may require disinfection.

## F. STORAGE AND DISPOSAL

### 1. STORAGE

Store CHLORTECH in a cool dark area in original container. Avoid storage in direct sunlight. In case of spill, flood with water before discarding to drain. Do not contaminate water, food or feed by storage or disposal.

### 2. DISPOSAL

Triple rinse container. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

### 3. PRACTICAL TREATMENT AND FIRST AID

If swallowed, feed bread soaked in milk, followed by olive oil or cooking oil. For contact with eyes or skin, flush with cold water for at least fifteen minutes.

## G. PREPARATION OF ACTIVATED SOLUTIONS

Citric Acid should be used with CHLORTECH products in strict accordance with label directions. Always use in well ventilated area when activating CHLORTECH solutions. Avoid any fumes that may occur. Avoid splashing of active concentrate as bleaching of clothes may occur.

For 500 ppm activated solutions: Place 3 1/4 fl oz of CHLORTECH concentrate per gallon of working solution into a clean, plastic pail. Measure out 10 grams of citric acid. Allow five minutes for reaction and for citric acid to dissolve. Avoid any fumes that may occur. Dilute active concentrate with one gallon clean, potable water per each 3 1/4 fl oz concentrate.

For 50 ppm activated solutions: Place 3 1/4 fl oz of CHLORTECH concentrate per gallon of working solution into a clean, plastic pail. Measure out 10 grams of citric acid. Allow five minutes for reaction and for crystals to dissolve. Avoid any fumes that may occur. Dilute active concentrate with 10 gallons clean, potable water each 3 1/4 fl oz concentrate.

STORAGE AND DISPOSAL: Store in a cool, dry place. If spilled, flush to drain with water.

### DILUTION CHART FOR CHLORTECH For Diluting 2% (20,000 ppm) ClO<sub>2</sub>

PARTS PER MILLION			
1 ppm	.0064 fl oz per gallon	or	.05 ml per liter
5 ppm	.032 fl oz per gallon	or	.25 ml per liter
10 ppm	.064 fl oz per gallon	or	.5 ml per liter
20 ppm	.128 fl oz per gallon	or	1.0 ml per liter
40 ppm	.256 fl oz per gallon	or	2.0 ml per liter
50 ppm	.320 fl oz per gallon	or	2.5 ml per liter
80 ppm	.512 fl oz per gallon	or	4.0 ml per liter
100 ppm	.640 fl oz per gallon	or	5.0 ml per liter
200 ppm	1.280 fl oz per gallon	or	10.0 ml per liter
400 ppm	2.560 fl oz per gallon	or	20.0 ml per liter
500 ppm	3.200 fl oz per gallon	or	25.0 ml per liter
1,000 ppm	6.400 fl oz per gallon	or	50.0 ml per liter
2,500 ppm	16.000 fl oz per gallon	or	125.0 ml per liter

#### 1 Gallon of 2% CHLORTECH Yields:

4,000 Gallons of	5 ppm
2,000 Gallons of	10 ppm
1,000 Gallons of	20 ppm
500 Gallons of	40 ppm
400 Gallons of	50 ppm
250 Gallons of	80 ppm
200 Gallons of	100 ppm
100 Gallons of	200 ppm
50 Gallons of	400 ppm
40 Gallons of	500 ppm
20 Gallons of	1,000 ppm
8 Gallons of	2,500 ppm

THE FOLLOWING PAGES ARE FROM:

**"CHEMISTRY AND TECHNOLOGY OF  
FOOD PRODUCTS - VOLUME I"**

by MORRIS B. JACOBS

INTERSCIENCE PUBLISHERS, INC. 1951,  
MACK PRINTING CO.

## Chapter XVII

# WASHING, DETERGENCY, SANITATION, AND PLANT HOUSEKEEPING

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Close attention to sanitation and plant housekeeping is essential for the highest achievement in the operation of any business concerned with food and food products. A sound working knowledge of washing and detergency and a diligent application of it are necessary if high standards of sanitation and plant housekeeping are to be maintained. Public health and legal regulations (see Chapter XIV) and esthetic tastes require a certain degree of sanitation. High standards of sanitation and plant housekeeping pay dividends through improved quality and lower spoilage of products, better product acceptance, less loss of time through accidents and plant breakdowns, and improved employee morale.

It will be the aim in this discussion to present certain general principles and to call attention to various kinds of materials and methods which are available for use in cleaning and plant housekeeping, rather than to attempt to present detailed directions for handling the multitudinous specific problems which exist in various kinds of food processing plants. First, we shall consider washing and detergency, and then give attention to the broader subjects of sanitation and plant housekeeping.

### I. WASHING AND DETERGENCY

Old as the problems of cleaning and washing are, and in spite of the large amount of research which has been done on these problems, there are many phases still incompletely understood insofar as the details of the chemistry and physics involved are concerned.

#### 1. Principles of Washing

Washing may be considered as involving three steps: (1) separation of the soil from the object to be cleaned; (2) carrying the soil away and suitably disposing of it; (3) leaving the surface being cleaned in the desired condition. Throughout the literature on washing and detergency one reads much of such terms as neutralization, saponification, surface tension, interfacial tension, wetting power, emulsification, deflocculation, alkalinity, pH, buffering capacity, rinsability, colloidal prop-

erties, etc. Such factors as neutralization, surface tension, interfacial tension, wetting power, etc., are all factors which enter into the actual separation of the soil from the surface, the deflocculation (which in turn involves the concentrations of surface-active agents) and the carrying away and disposing of the soil. The main object to be achieved is the removal of the soil from the surface and its redeposition upon the surface at a place where it will cause no further trouble. The condition of the surface after the cleaning operation is dependent upon the surface, the rinsability of the surface, the rinsing process, germicidal properties, and the drying of the object.

There are various theories to fit certain observations and but no single theory so far advanced which explains all the processes seem to be rather complex. The mechanisms play a part. The relative type of cleaning problem involved enters into the situation.

Those interested in the details of the subject are referred to the literature<sup>1</sup> for such information. There are two types of explanation of the phenomena.

It is usually assumed that soil contains some free fatty acids which are emulsified by the alkaline materials in the cleaning solution. These substances which may be present in the soil are emulsified by the interfacial tensions. This, together with the mechanical action, tends to loosen the soil from the surface. The formation of a protective film is pictured as consisting of the soluble (hydrophilic) groups of the soil and the insoluble (hydrophobic) portions of the soil dissolved in the oily portions of the soil, which have

<sup>1</sup>N. K. Adam, *J. Soc. Dyers and Colourists*, 612 (1938). J. Powney *et al.*, *Textile Research Journal*, with Vol. 31 (1935) and continuing Vol. 32, 84 (1948). F. D. Snell, *Food Research*, 2256 (1949). E. K. Goette, *J. Colloid Chem.*, 4 (1949).

erties, etc. Such factors as neutralization, pH, alkalinity, buffering capacity, surface tension, interfacial tension, wetting ability, and mechanical action are all involved in the actual separation of the soil from the surface being cleaned. Emulsification and deflocculation (which in turn involve such factors as surface and interfacial tension, concentrations of surface-active agents, and mechanical action) are involved in carrying away and disposing of the soil which has been loosened from the surface. The main object to be achieved in this second step is to prevent the soil from being redeposited upon the surface and to dispose of it in a manner which will not cause further trouble. The condition in which the surface of the object is left after the cleaning operation is dependent upon the action of the cleaning solution upon the surface, the rinsibility of the wash solution, hardness of water, temperature of final rinse process, germicidal properties of the wash and rinse solutions, and method of drying the object.

## 2. Theories of Cleaning

There are various theories concerning the mechanism of cleaning. Each appears to fit certain observations and facts concerning certain kinds of cleaning operations, but no single theory so far advanced is adequate to explain all observations. Cleaning processes seem to be rather complicated phenomena. Various types of mechanisms play a part. The relative importance of each depends upon the particular type of cleaning problem involved and the many variable conditions which may enter into the situation.

Those interested in the details of these various theories may refer to the literature<sup>1</sup> for such information. However, it may be worth while to consider one or two types of explanation of what happens in the cleaning process.

It is usually assumed that many soils consist in part of oily substances which contain some free fatty acids. Soap formed by the reaction of these free fatty acids with the alkaline materials in the wash solution, together with other surface-active substances which may be present in the wash solution, tends to lower surface and interfacial tensions. This, together with the accompanying mechanical action, tends to loosen the soil from the surface and to emulsify, disperse, or deflocculate it by the formation of a protective film around each tiny speck of soil. The protective film is pictured as consisting of surface-active molecules, so oriented that the water-soluble (hydrophilic) groups face outward into the wash solution, and the oil-soluble (hydrophobic) portions of the molecules face inward toward the speck of soil being dissolved in the oily portion of the soil. These protective films tend to keep the particles of soil, which have just been removed from the surface, from collecting or

<sup>1</sup>N. K. Adam, *J. Soc. Dyers Colourists*, 53, 121 (1937). L. P. Hall, *Am. Dyestuff Repr.*, 27, 612 (1938). J. Powney *et al.*, see long series of articles in *Trans. Faraday Soc.*, beginning with Vol. 31 (1935) and continuing over many years. W. C. Preston, *J. Phys. & Colloid Chem.*, 52, 84 (1948). F. D. Snell, *Food Inds.*, 13, No. 10, 48 (1941) and *Chem. & Eng. News*, 27, 2256 (1949). E. K. Goette, *J. Col. Sci.*, 4, 459 (1949). R. Neu, *Seifen, Ole, Fette, Wachse*, 75, 4 (1949).

coalescing into aggregates large enough to separate out from the washing solution. They also tend to prevent the redeposition of this soil upon the surface which has just been cleaned.

Electric charge phenomena are considered to play a part in dispersion and deflocculation and also in adsorption of the soil by colloids when colloidal detergent materials are used.

### 3. Factors Affecting Cleaning Operations

There are many different factors which have an influence on the cleaning operation. Some of the more important to be considered in connection with any given cleaning problem are listed in Table I. Best cleaning action can be had only by a

TABLE I  
FACTORS AFFECTING CLEANING OPERATIONS

Surface to be cleaned.....	Chemical and physical properties, size, shape, location
Soil to be removed.....	Kind, amount, time on surface, action on surface
Purpose of cleaning.....	
Water supply.....	Abundance, heating facilities, hardness, iron, other impurities
Cleaning agent.....	Specially adapted to job or just general purpose type, effect on object being cleaned, effect on user, effect on brushes or other cleaning equipment
Temperature.....	Effect on soil, on object being washed, on washing, on rinsing action
Cleaning method and equipment...	Hand, machine, simple, complex, brushing, spraying, dipping, soaking, order of operations, time of action
Human factors.....	Interest and skill of workmen

proper balance among these various factors. Some of the factors will be fixed by the nature of the particular job at hand. Intelligent adjustment of the variable factors to the fixed factors will be needed. This will usually require some experimentation and trial-and-error observations.

### 4. Phenomena Involved in Cleaning

There are a great many different methods of cleaning and types of phenomena involved in cleaning operations. One way of classifying these is shown in Table II. In most cases, several of the phenomena listed in Table II are involved simultaneously or successively in each cleaning job. The relative importance of the various phenomena is not the same for different cleaning operations. Selection of methods which utilize the different phenomena in approximate order of relative importance to the task at hand is important. Again this calls for intelligent experimentation and observation.

### 5. Chemical Aids for Cleaning and Sanitation

A great many different individual chemicals possess cleaning properties and there are hundreds of different types of cleaning combinations used. It will not

Physical.....	Abrasive Flushing Agitation Screening Gravitation Motion Wetting
Chemical.....	Neutral Acidic
Electrical.....	Electrolytic
Thermal.....	Heating Cooling

be possible here to consider even to discuss fully the factors used in these cleaning combinations. The more important of the factors to their detergent properties. A few chemicals will be

So much is said about the nature that there is some bearing on the type of reaction of the comparative alkaline salts used in detergents of alkalinity which solution from a study of the data.

In Tables III and IV cleaning purposes, together and usefulness. It should be the most efficient and more than a single chemical cleaning action than any usefulness of individual combinations of these chemicals.

In the use of chemicals to the concentration used that if a little does some be true for each chemical universally true. Generally combination, which is the vary for each chemical property of the chemicals.

TABLE II  
BASIC PHENOMENA OF DETERGENCY

Physical.....	Abrasive, brushing, burnishing, wiping, etc. Flushing, hosing, spraying, etc. Agitation, stirring, vibration, tumbling, etc. Screening, filtering, selective adsorption, etc. Gravitational, settling, flotation, centrifuging, etc. Moving materials, conveying, turning, pumping, etc. Wetting, surface and interfacial phenomena
Chemical.....	Neutralization, oxidation, reduction, exchange reaction, adsorption, enzyme action, solution, emulsification, deflocculation, precipitation, etc.
Electrical.....	Electrolytic, electrostatic, magnetic, adsorption, and colloidal phenomena
Thermal.....	Heating, cooling, expansion, contraction, vaporization, condensation, drying, increasing chemical action, etc.

be possible here to consider even a small fraction of these various combinations or even to discuss fully the much smaller number of individual chemicals which are used in these cleaning compositions. An attempt will be made, however, to list the more important of the chemicals and in some cases to give information relating to their detergent properties. See Table III for examples of these types of materials. A few chemicals will be discussed individually later in the chapter.

So much is said about alkali strength and buffering capacity in detergent literature that there is sometimes a danger of overlooking other factors which have a bearing on the type of results obtained. However, it is useful to have some conception of the comparative alkalinity and neutralizing capacity of the alkalies and alkaline salts used in detergency. A rough idea of the relative strength and amount of alkalinity which solutions of some of these substances provide may be obtained from a study of the data in Table IV.

In Tables III and IV are listed most of the important chemicals available for cleaning purposes, together with certain information concerning their properties and usefulness. It should be understood, however, that in many cleaning operations the most efficient and most effective cleaning materials will be found to consist of more than a single chemical. Usually certain combinations of chemicals give better cleaning action than any single chemical. An understanding of the properties and usefulness of individual chemicals, however, is helpful in the selection of combinations of these chemicals for use in specific cases.

In the use of chemicals for cleaning purposes more attention should be paid to the concentration used. Too often, the worker proceeds under the assumption that if a little does some good, more will do proportionally greater good. This may be true for each chemical within rather narrow limits, but it certainly is not universally true. Generally, there is a concentration for each chemical, or chemical combination, which is the optimum and economical concentration to use. This will vary for each chemical and for each application depending upon the particular property of the chemical which plays the dominant role in the particular cleaning

job and method being used. Sometimes a high concentration will actually give poorer results than will a lower concentration. Sometimes no value at all is received until a certain minimum concentration is reached. In other cases, even very small amounts of chemical do good and continue to give proportionally better results over a long range of increased concentrations. The optimum concentration to use from the standpoint of soil removal may not always be the most economical concentration to use from the financial standpoint. Not only the cost per pound of the chemical itself, but also the other cleaning costs, such as for hot water, labor, etc., and the variation of these costs with the detergent concentration have a bearing upon the final cleaning costs. Most users err on the side of using more detergent than is required or is economical. Intelligent use of experience with each particular application is necessary to determine the proper concentration to be used.

TABLE III  
CHEMICALS USED FOR WASHING, DETERGENCY, AND PLANT SANITATION

CLASSES	
<i>Classes:</i> solvents, surface-active agents, alkalies, acids, salts, abrasives, reducing agents, oxidizing agents, inhibitors, enzymes, germicides, adsorbents, water softeners, rodenticides, insecticides	
1. Solvents	
Water <sup>2</sup>	By far the most important. Water from most supplies contains <i>hardness</i> and other dissolved impurities, some or all of which may need to be removed before use if best results are to be obtained. Effect of hardness on chemicals and process used should be considered.
Other solvents	Organic solvents such as various hydrocarbons and chlorinated hydrocarbons are of limited usefulness in the food field but are of major importance in some industrial cleaning fields. In using organic solvents, one must consider toxicity, inflammability, recovery and reuse, and other such factors. Select on basis of "like dissolves like."
2. Surface-Active Agents	
Ordinary soaps <sup>3</sup>	Salts of mixed, straight-chain fatty acids of length C <sub>8</sub> to C <sub>18</sub> . Properties vary with such factors as chain length, amount of unsaturation, proportions of different fatty acids present, and alkalies used in making the soap. In general, the lower titer soaps (those made from short-chain and/or unsaturated fatty acids) are more soluble and better suited to lower temperature use than are the higher titer soaps (those made from longer chain and saturated fatty acids). Sodium soaps are the most common, but potassium and ammonium soaps are also used for washing purposes. They are "anionic" surface-active agents, <i>i.e.</i> , the large active ion carries a negative charge. The pH of solutions of ordinary soaps is of the order of 10. Soaps possess excellent detergent and wetting properties but are useful in such capacities only in alkaline solutions of pH about equal to or greater than that of the pure soap. The hardness in water precipitates soaps and interferes with their action. Unless the water is otherwise softened, more than sufficient soap to precipitate all of the hardness must be added before the soap can fully exert

Table continued

<sup>2</sup>W. D. Collins *et al.*, *U. S. Geological Water-Supply, Paper 658* (1934). A. A. Hirsch, *Manual for Water Plant Operators*, Chem. Publishing Co., New York, 1937. F. W. Smither, *Washing, Cleaning and Polishing Materials*, U. S. Bur. Standards, Circ. C424, Govt. Printing Office, Washington, D. C., 1939. K. G. Weckel, *Food Inds.*, 14, No. 1, 47, 85 (1942).

<sup>3</sup>*Standards on Soaps and Other Detergents* Am. Soc. Testing Materials, Philadelphia, 1945. G. Martin, *The Modern Soap and Detergent Industry*, Vols. I-III, Van Nostrand, New York, 1932. F. W. Smither, *Washing, Cleaning, and Polishing Materials*, U. S. Bur. Standards, Circ. C424, Govt. Printing Office, Washington, D. C., 1939. I. U. S. Stanislaus and P. B. Meerbott, *American Soap Maker's Guide*, Baird, New York, 1947.

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Class

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Cationic

<sup>4</sup>M. L. Anson *et al.*, *J. Am. Chem. Soc.*, 70, 12, 105 (1948). J. W. Mc  
No. 10 (1949). C. E. Mull  
74; No. 2, 32, 73 (1938).  
*News*, 29, 36 (1951). F. J  
and J. J. Ayo, Jr., *Ind. E*

**"Soapless"  
soaps, syn-  
thetic deterg-  
ent, and wet-  
ting agents<sup>4</sup>**

its detergent action. In softened water a soap concentration of the order of 0.1% is sufficient in most cases. The cleaning ability of soap solutions can be considerably enhanced by the addition of suitably selected alkaline salts. Addition of wrong materials can decrease the cleaning action.

These chemicals represent attempts to make compounds which possess the good detergent and wetting properties of ordinary soaps without the disadvantages of being adversely affected by acids, salts, and water hardness, and are of comparatively recent origin. The hundreds of different chemicals which have been suggested for this purpose may be considered as belonging to one of three general classes: "anionic," "cationic," or "nonionic," depending upon whether the active portion is negative, positive, or neutral. See Chapter XXXVII. Solutions of most of these newer materials have a pH near that of neutrality (usually between 5 and 8), but can be used in solutions with much higher and lower pH values. Some of these materials possess marked bacteriostatic and germicidal properties. It is difficult, expensive, and in some cases impossible, to prepare some of these new chemicals by themselves in the form of dry solids. The rate of dissolving of the pure chemicals is sometimes very slow. Therefore, many of these new materials which are available commercially are sold in the form of aqueous solutions of various concentrations. In other cases they are prepared in a dry form by mixture with some dry but easily water-soluble material, such as sodium sulfate. The wetting and detergent effectiveness of many of these newer surface-active agents is greater in neutral salt solutions than in pure water. Thus the sodium sulfate serves as more than a mere carrier or inert filler. A few examples of these newer detergent materials available commercially are listed below, classified by chemical structure:

Class	Chemical type	Trade names
Anionic	Alkyl sulfates	Alropon, Dreft, Duponols, Orvus, Tergitol O8
	Alkyl sulfonates	Detanol A, MP-189, MP-646-S
	Alkyl aryl sulfonates	Aerosol OS, Alkanol B, Alroterge, Kreelons, Nacconols, Oronite, Santomerse No. 1, Swerl
	Dialkyl esters of sodium sulfosuccinic acid	Aerosol AY, IB, MA, OT
	Alkyl sulfated monoglycerides	Arctic Syntex M, Vel
	Fatty amide condensate	Igepon T, Miranol 74
	Alkylated aryl polyether sulfonate	Triton X-200, Triton X-300
Cationic	Trialkylbenzylammonium halide:	
	Alkyldimethylbenzyl ammonium chloride	Agent M, BTC, Cetylron, Decab, Octab, Roccal, Rodalon
	Pyridinium compounds:	
	Alkylpyridinium bromide	LPC
	Acylcolominoformylmethylpyridinium chloride	Emulsept
	Alkylpyridinium chloride	Ceepryn
	Others:	
	Alkyldimethylethylammonium bromide	Bionol ST, Ethyl Cetab
	Alkyltrimethylammonium chloride	Arquad-12, -14, -16, and -18, Cetab

Table continued

<sup>4</sup> M. L. Anson *et al.*, *Ann. N. Y. Acad. Sci.*, **56**, 347 (1946). H. N. Glassman, *Bact. Revs.*, **12**, 105 (1948). J. W. McCutcheon, *Chem. Ind.*, **61**, 811 (1947) and *Soap*, **25**, No. 8, No. 9, No. 10 (1949). C. E. Mullin, *Soap*, **13**, No. 11, 30, 74; No. 12, 27, 73 (1937); and **14**, No. 1, 30, 74; No. 2, 32, 73 (1938). F. D. Snell, *Ind. Eng. Chem.*, **35**, 107 (1943) and *Chem. & Eng. News*, **29**, 36 (1951). F. J. Van Antwerpen, *Ind. Eng. Chem.*, **35**, 126 (1943). M. L. Kastens and J. J. Ayo, Jr., *Ind. Eng. Chem.*, **42**, 1626 (1950).

Table continued

934 A. A. Hirsch.  
937 F. W. Smither,  
C424, Govt. Printing  
7, 85 (1942).  
eris, Philadelphia.  
Van Nostrand, New  
erials, U. S. Bur.  
I. U. S. Stanislaus

TABLE III (Continued)

	Paradiisobutylphenoxy-ethoxyethyl, dimethylbenzyl-ammonium chloride (monohydrate)	Hyamine 1622
Nonionic	Fatty alkylol amine condensate	Alrosol C
	Polyoxyethylene glycol stearate	G-2160
	Alkylarylethylene oxide condensates	Antorox 200, Glim, Igepal CA, Triton X-100
	Other	Nyon 218, Neutronyx 834

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### 3. Alkalies<sup>6</sup>

<b>Sodium hydroxide</b>	Sodium hydroxide (caustic soda, lye) is the most important alkali from a detergent standpoint. It is used alone in concentrations of the order of 1 to 3% very extensively in the milk and carbonated beverage industries for machine washing of bottles. It serves as both a detergent and a germicide in this use. Sometimes other detergent materials are used with it to modify results. Other applications of caustic soda itself as a detergent in the food field are few and small in comparison to its use in bottle washing. However, very large amounts of it enter the detergent field indirectly through its use for the manufacture of soaps and other alkaline detergent materials. It is also used for peeling fruits and vegetables. Caustic soda must be handled and used with extreme care to prevent the user from receiving bad caustic burns. It is too corrosive for many uses. Some of the alkaline salts mentioned below may be used instead of caustic soda for many purposes. These salts are less dangerous to handle and often do a better job than can caustic soda alone.
<b>Potassium hydroxide</b>	Potassium hydroxide (caustic potash) is seldom used directly as a detergent because it is much more expensive than caustic soda. It is used to make potassium soaps. Potassium soaps are more expensive than corresponding sodium soaps and therefore their use is limited. They are more soluble than the corresponding sodium soaps and are used for special purposes, where increased solubility is desired, for instance, in liquid hand soaps for use in liquid soap dispensers such as are installed in washrooms.
<b>Ammonium hydroxide</b>	Ammonium hydroxide can be used where a mild alkaline cleaning material is desired. However, it is seldom used. Its main advantage over other alkaline materials is that it is completely vaporizable at ordinary temperatures and therefore leaves no residue. It is also seldom used for making soaps, some of its soaps being unstable.
<b>Amines and organic bases</b>	In the last few years, there has been some work in the direction of producing various amines and certain organic bases which are finding some use as detergents. For instance, such compounds as triethanolamine can react with fatty acids to give triethanolammonium soaps, which have useful detergent properties. Some of the synthetic surface-active agents are derived from amines.

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### 4. Acids

<b>Hydrochloric, sulfuric, and nitric acids</b>	These are strong acids, useful for some special cleaning purposes but hazardous to handle. Their direct uses for detergent purposes are limited. Indirectly, they contribute to detergency in that they are employed in the manufacture of other cleaning materials.
<b>Organic acids</b>	Certain organic acids such as lactic, gluconic, hydroxyacetic, and levulinic acids have been used for certain detergent purposes. The direct use of organic acids as detergents is very limited in comparison to their indirect use in the manufacture of soaps and other surface-active agents.

Table continued

<sup>6</sup>D. D. Gatts, *Soap*, 13, No. 7, 28 (1937). J. L. Hileman, 9th Ann. Rept. N. Y. State Assoc. Dairy Milk Inspectors, p. 71 (1935). P. D. Liddiard, *Chemistry & Industry*, 60, 480, 684, 713 (1941). E. O. Rounsfall, *Dairy Inds.*, 2, 66 (1937).

<b>Kinds</b>	There are n with the ai various way
<b>Neutral</b>	Neutral salt nection with
<b>Buffers</b>	Salts of stro as buffering changes in of substances
<b>Acid</b>	Acid salts, of moderate and handle
<b>Alkaline</b>	The greatest salt. In this as the sodium discussed. of this table property, ar

<b>Borates</b>	Borax (sodium borate) solutions. It poses, but in which are be (NaBO <sub>3</sub> ·H <sub>2</sub> O)
<b>Carbonates</b>	Sodium carbonate for its own d ture of other and also in known to th available in Two hydrate cially, but as sal soda or washing pur soda or bicar gent value. reduce the Na <sub>2</sub> CO <sub>3</sub> ·2H <sub>2</sub> bonate. It sodas are av soda, someti alkaline solu soda itself. ash are requ obtained.
<b>Phosphates: ortho-<sup>7</sup></b>	Trisodium or Na <sub>3</sub> PO <sub>4</sub> ·12H <sub>2</sub> O detergent salt

<sup>7</sup>C. W. Rink, 16th Rept. Eng. Chem., 24, 76, 1051 (1 and Polishing Materials, U. D. C., 1939, pp. 22-31.

<sup>8</sup>J. R. Skeen, *Soap*, 24, N

## 5. Salts

<b>Kinds</b>	There are many kinds of salts used for detergent purposes. Most cleaning is done with the aid of some salt. Ordinary soap is a salt. Salts may be classified in various ways, such as neutral, buffer, acid, and alkaline.
<b>Neutral</b>	Neutral salts like sodium chloride and sodium sulfate have detergent uses in connection with some of the newer types of synthetic detergents.
<b>Buffers</b>	Salts of strong acids and weak bases, or of weak acids and strong bases, are useful as buffering agents which tend to protect the detergent solution from large changes in pH due to changes in concentration or the addition of alkaline or acidic substances into the wash solutions.
<b>Acid</b>	Acid salts, such as sodium acid sulfate, are useful when an acid cleaning solution of moderate strength is desired. The acid salt is usually more convenient to ship and handle than the corresponding acid.
<b>Alkaline</b>	The greatest proportion of all cleaning work is done with some type of alkaline salt. In this class fall all ordinary soaps and such widely used detergent materials as the sodium carbonates, silicates, and phosphates. Soaps have already been discussed. The other common alkaline salts will be presented in the next section of this table. Many other materials, listed elsewhere because of some special property, are also salts of one kind or another.

6. Alkaline Salts<sup>6</sup>

<b>Borates</b>	Borax (sodium tetraborate), $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ , produces only mildly alkaline solutions. It was formerly widely used for water softening and detergent purposes, but in recent years has been increasingly displaced by other alkaline salts which are better suited for most detergent uses. Sodium perborate, $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$ , ( $\text{NaBO}_3 \cdot \text{H}_2\text{O}$ is also available) is a mild oxidizing agent.
<b>Carbonates</b>	Sodium carbonate is one of the most important alkaline detergent salts, not only for its own detergent uses, which are many, but because it is used in the manufacture of other detergent materials. It is used alone for general detergent purposes, and also in combination with other chemicals. The anhydrous form, $\text{Na}_2\text{CO}_3$ , known to the trade as <i>soda ash</i> , is the most commonly used form. Soda ash is available in different states of granulation, known as <i>dense</i> , <i>light</i> , and <i>extra light</i> . Two hydrated forms, $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ , are available commercially, but are not as economical to use as soda ash. The decahydrate, known as <i>sal soda</i> or <i>washing soda</i> , has for years been used in homes for water softening and washing purposes. Sodium bicarbonate, $\text{NaHCO}_3$ , commonly known as <i>baking soda</i> or <i>bicarbonate of soda</i> , provides very mildly alkaline solutions of limited detergent value. The bicarbonate is sometimes used with other alkaline materials to reduce the alkalinity of their solutions. Sodium sesquicarbonate, $\text{NaHCO}_3 \cdot \text{Na}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$ , contains equimolecular quantities of sodium carbonate and bicarbonate. It may be used where a mildly alkaline agent is desired. Modified sodas are available commercially as several combinations of soda ash and caustic soda, sometimes called <i>causticized ash</i> . These provide a means of obtaining highly alkaline solutions without quite the handling hazards involved in using caustic soda itself. In case carbonate solutions of lower alkalinity than supplied by soda ash are required, soda ash-bicarbonate mixtures of various proportions can be obtained.
<b>Phosphates: ortho<sup>7</sup></b>	Trisodium orthophosphate, with twelve molecules of water of crystallization, $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ , known to the trade as TSP, is one of the most important alkaline detergent salts. It is widely used alone for a great variety of detergent purposes.

Table continued

<sup>6</sup>C. W. Rink, *16th Rept. N. Y. State Assoc. Milk Sanit.*, p. 163 (1942). F. D. Snell, *Ind. Eng. Chem.*, 24, 76, 1051 (1932); 25, 162, 1240 (1933). F. W. Smither, *Washing, Cleaning and Polishing Materials*, U. S. Bur. Standards, Circ. C424, Govt. Printing Office, Washington, D. C., 1939, pp. 22-31.

<sup>7</sup>J. R. Skeen, *Soap*, 24, No. 11, 46 (1948). F. D. Snell, *Ind. Eng. Chem.*, 23, 470 (1931).



inations. It is superior as a water softener in food emulsification properties, and globules. The best purposes is the best. It is also available but are on hydrogen orthophosphate, which also provide

anhydrous form and as a dry TSPP or as pyro. The dry form which is of less alkaline than TSP properties. It is much more seldom used alone as a component of vari-

and the glassy poly-t detergent material. It is essential. It dissolves more readily nonhygroscopic phosphates do in deter-

dehydrated than pyro- phosphates. Those of commerce are in the form of broken pieces of the most highly dehydrated  $P_2O_5$  in pure form, are fine salt. However, in TSPP or pyro is present one or more such agents manufacture or prior to phosphate,  $Na_3P_2O_7$ , is a very good water softener against magnesium phosphate. These glassy phosphates in their softening action of any precipitate. Among other detergent phosphates in detergent solutions, keeping solutions of hydrolyzing promote this revision the others mentioned. Phosphates are quite stable in storage and shipment, and several of them are used for some cleaning

Table continued

No. 1, 25, 69 (1939).  
29 (1941).  
P. Partridge, *Chem.*  
6, 45 (1942). K.  
*Milk & Ice Cream J.*,

4, 737 (1942). J. D.  
2, 1 (1934). R. C.  
41, 37 (1949).

	purposes. These and others are used in combination with soap or other chemicals as washing agents. These silicates range in alkalinity from the very highly alkaline compound, sodium orthosilicate, down to certain water glasses which are only very slightly alkaline. The detergent value of the silicates depends not alone on their alkalinity but to a very large extent upon other factors, such as their colloidal and dispersive properties, and their ability to protect surfaces being cleaned from the damaging effects of highly alkaline solutions.
ortho-	Sodium orthosilicate, $Na_2SiO_4$ , is the most alkaline silicate commercially available. It approaches caustic soda in its alkaline strength. It is not used for general cleaning purposes, but is useful for special jobs which require very caustic solutions. This product is very hygroscopic and should be stored in a tightly closed container to prevent it from deliquescenting.
sesqui-	Sodium sesquisilicate, $Na_4Si_2O_7 \cdot 11H_2O$ , is less alkaline than the orthosilicate, but is too strong for general detergent use and therefore serves only when very strongly alkaline solutions are required. This product, too, is hygroscopic.
meta-	Sodium metasilicate, available in the anhydrous form, $Na_2SiO_3$ , and as the pentahydrate, $Na_2SiO_3 \cdot 5H_2O$ , is much weaker than either the ortho- or the sesquisilicate, but is considerably stronger than TSP or soda ash. Several other hydrates can be prepared, but are not so commonly available as the above forms. Sodium metasilicate represents a happy medium between the highly caustic products and the more siliceous products, combining the good detergent action of an alkali with the special colloidal and protective properties attributable to the silicate anion. It is very widely used alone as a detergent material and is an important component of many detergent combinations. It is slightly hygroscopic but not sufficiently so to give much difficulty in handling except under very humid conditions. The product is too strong to be recommended for uses where the unprotected hands of the user are exposed to its solution.
Less alkaline silicates, water glass	Silicates are frequently described in terms of the proportion of alkali to silica present in them. This composition is expressed in the form of the molecular ratio of $Na_2O$ to $SiO_2$ . The $Na_2O:SiO_2$ ratio of sodium orthosilicate is 2:1, of sodium sesquisilicate 1.5:1, and of sodium metasilicate 1:1. All of the above substances are readily soluble in water. There are available a number of dry, powdered sodium silicate products which have a $Na_2O:SiO_2$ ratio of less than 1:1, although it is claimed that no definite chemical compounds, in the strict meaning of the term, exist with ratios of less than 1:1. As the ratio of $Na_2O$ to $SiO_2$ decreases, the difficulty of getting the dry silicates into solution increases. The lower ratio silicates are therefore usually supplied in the form of concentrated solutions. Ordinary water glass has a $Na_2O:SiO_2$ ratio of less than 1:3. These low-ratio silicates are seldom used alone for detergent purposes, but have long been used as soap builders. They are not as important for cleaning in food industries as the more alkaline silicates.

#### 7. Abrasives<sup>11</sup>

Pumice stone, powdered silica, emery, steel wool, etc.	Abrasives are seldom used alone. When properly selected to give strong abrasive action with as little damage as possible to the surface being cleaned and in conjunction with other cleaning agents, they are very useful, especially for the removal of burned-on foodstuffs and other soils which adhere very tenaciously to the surface to be cleaned. Steel or copper wool and such abrasive aids are not permissible in some operations due to the possibility of leaving fragments which are not easily rinsed away and may thus contaminate food prepared in equipment cleaned with them.
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#### 8. Reducing Agents<sup>12</sup>

Sodium bisulfite, sodium sulfite, etc.	Sodium bisulfite, sodium sulfite, and other reducing agents are useful in certain specialized cleaning problems, especially those involving the removal of discolorations and stains.
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Table continued

<sup>11</sup> *Soap*, 19, No. 4, 30, 63 (1943).

<sup>12</sup> F. W. Smither, *Washing, Cleaning and Polishing Materials*, U. S. Bur. Standards, Circ. C424, Govt. Printing Office, Washington, D. C., 1939, p. 29.

TABLE III (Continued)

9. Oxidizing Agents <sup>12</sup>	
Hypochlorites, peroxides, perborates, oxalic acid, etc.	Oxidizing agents, as well as reducing agents, are useful in certain specialized cleaning problems involving the removal of discolorations and stains.
10. Corrosion Inhibitors <sup>13,14</sup>	
For alkaline solutions	Many surfaces are damaged by strongly alkaline or strongly acid solutions unless suitable inhibitors are present to protect the surface or modify the action of the solution. Silicates, when present in proper amounts, will protect aluminum from the attack of alkaline cleaning solutions, and reduce the attack of alkalies on tin and other surfaces. Chromates, barium salts, sodium silicofluoride, and some other salts are reported to be helpful in protecting tin and other metal surfaces. In the case of tin, at least part of the damage is done by oxygen dissolved in the alkaline wash solution. Removal of the dissolved oxygen by means of a reducing agent such as sodium sulfite will prevent much of the attack on tin.
For acid solutions	A number of organic substances, such as certain amines, have the ability to reduce the attack of acid solutions on metal surfaces.
11. Enzymes <sup>15</sup>	
Proteolytic, starch solubilizing, fat splitting	Enzymes have been employed in only a very limited way for cleaning purposes but deserve more attention. Care must be used to select conditions of pH and temperature suitable for the particular enzyme used. Enzymes to be used must, of course, be selected on the basis of the type of soil to be removed. For instance, diastase, a starch-solubilizing enzyme, is useful in the removal of a starch soil but would not be useful in the removal of a fat soil.
12. Germicides	
Caustic soda, available chlorine compounds	Caustic soda and various hypochlorites are most common. Certain phenolic derivatives, <i>N</i> -chloro compounds, and new surface-active agents are finding use in this field. Germicides and germicidal methods are discussed elsewhere in this chapter. (See Sections I.8d and II.1e.)
13. Adsorbents	
Sawdust, celite, bentonite, etc.	Sawdust, celite, bentonite, and other similar materials possess adsorptive properties which are of value in certain cleaning and plant housekeeping operations. Usually such materials are used in conjunction with other cleaning agents for the purpose of adsorbing and holding on to certain types of soil so that they can more easily be carried away from the surface being cleaned.
14. Water Softening Agents <sup>16</sup>	
Inorganic, organic, exchange, precipitating, sequestering	From the standpoint of cleaning, water softening consists of either removing the calcium and magnesium from the water completely or in reducing the concentration of calcium and magnesium ions to a very low value by tying them up in the form of precipitates or slightly ionized complexes. For complete removal so-called exchange agents are used. These are insoluble materials which have the property of trading hydrogen, sodium, or other innocuous cations for the calcium and magnesium ions of the water as it passes through a bed of the material. These

Table continued

<sup>12</sup> C. L. Baker, *Ind. Eng. Chem.*, 27, 1358 (1935). R. Kerr, *J. Soc. Chem. Ind.*, 54, 217T (1935). B. E. Roetheli, and G. L. Cox, *Ind. Eng. Chem.*, 23, 1084 (1931). G. H. Botham and G. A. Dunnett, *J. Dairy Res.*, 16, 23 (1949).

<sup>13</sup> C. Schwartz, U. S. Pats., 2,303,397-400; 2,359,587, 2,391,647.

<sup>14</sup> H. Tauber, *The Chemistry and Technology of Enzymes*. Wiley, New York, 1949. A. L. Tappel, *Food Ind.*, 22, No. 8, 87 (1950). J. L. Wilson, unpublished experiments.

<sup>15</sup> C. P. Hoover, *Natl. Lime Assoc., Bull.* 211, 3rd ed. (1938). T. E. Larson, and A. M. Buswell, *Ind. Eng. Chem.*, 32, 130 (1940). F. J. Meyers, *ibid.*, 35, 658 (1943). O. Rice and E. P. Partidge, *ibid.*, 31, 58 (1939). H. E. Tiger and S. Sussman, *ibid.*, 35, 186 (1943).

exchange agent  
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such agents.  
Certain inorganic  
agents are used  
that the water  
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There are a  
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carbonate, etc.  
Often trapping

As insecticide  
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TABLE IV COMPAR

Chemicals (commercial grade)
Caustic soda.....
Sodium orthosilicate.....
Sodium sesquisilicate.....
Sodium metasilicate.....
Trisodium orthophosphate.....
Soda ash.....
Soap (ordinary, unbleached)....
Tetrasodium pyrophosphate.....
Sodium sesquicarbonate.....
Sodium tripolyphosphate.....
Sodium tetraphosphate.....
Borax.....
Sodium bicarbonate.....
Sodium metaphosphate.....

<sup>16</sup> Expressed as the number of phenolphthalein and methyl

<sup>17</sup> L. R. Parkinson, *Soap*, McGraw-Hill, New York, 1941. J. C. Ward, *ibid.*, 21, No. 16, No. 7, 24, No. 11, 45 (1941).

<sup>18</sup> H. Elishewitz, *Soap*, 23, 16, 135, 169, 191, (1947). E. Donohoe, *Mod. Sanitation*, (1950).

exchange agents may be inorganic compounds such as the *zeolites*, sodium aluminum silicates, or organic compounds of a carbonaceous or resinous type developed in recent years for this purpose. The calcium and magnesium may also be removed by the addition of chemicals such as soda ash or TSP to form compounds of low solubility, such as calcium carbonate, calcium phosphate, and magnesium hydroxide, and filtering to remove these precipitates. Often water treated with such agents is used without filtering. For many purposes this is very satisfactory. Certain inorganic compounds such as the polyphosphates are capable of *sequestering* the calcium and magnesium in slightly ionized, but soluble, complexes so that the water is softened without precipitation. A number of organic compounds have this sequestering ability. Those of commercial importance belong to a class known as polyaminocarboxylic acid compounds.

#### 15. Rodenticides

There are a number of chemicals useful for this purpose, some organic and some inorganic. A few are: Red squill, ANTU ( $\alpha$ -naphthylthiourea), barium carbonate, thallium sulfate, arsenic compounds, and 1080 (sodium fluoroacetate). Often trapping is most effective. See Chapter XIX and other special literature.<sup>17</sup>

#### 16. Insecticides

As insecticides and fumigants for insect control there are numerous chemicals in use. Since the war DDT (dichlorodiphenyltrichloroethane) has received much publicity. Others of proved value are such materials as rotenone, pyrethrum, arsenic and thallium compounds, carbon tetrachloride, methyl bromide, and various cyanides. For others and information on this subject see Chapter XVIII et seq. and other special literature.<sup>18</sup>

TABLE IV COMPARISON OF ALKALINITY OF SOME DETERGENT SUBSTANCES

Chemicals (commercial grade)	pH (approx. for soln. of the weight percent indicated)		Amount of alkalinity (approx. for a 0.5% solution) <sup>a</sup>	
	0.1%	0.5%	Phenolphthalein	Methyl orange
Caustic soda.....	12.0	12.7	122	122
Sodium orthosilicate.....	11.8	12.6	100	100
Sodium sesquisilicate.....	11.6	12.3	58	60
Sodium metasilicate.....	11.3	12.0	45	48
Trisodium orthophosphate.....	11.5	11.8	18	35
Soda ash.....	10.7	11.3	56	95
Soap (ordinary, unbuilt).....	10.2	..	..	..
Tetrasodium pyrophosphate.....	10.0	10.1	12	38
Sodium sesquicarbonate.....	9.6	9.7	28	68
Sodium tripolyphosphate.....	9.1	9.0	..	..
Sodium tetraphosphate.....	8.5	8.4	..	..
Borax.....	8.5	8.7	20	28
Sodium bicarbonate.....	8.0	8.2	3	61
Sodium metaphosphate.....	6.5	6.2	..	..

<sup>a</sup> Expressed as the number of milliequivalents of acid required to bring 1 liter of solution to the phenolphthalein and methyl orange end points.

<sup>17</sup> L. R. Parkinson, *Soap*, 20, No. 6, 123, 153 (1944). M. E. Parker, *Food-Plant Sanitation*, McGraw-Hill, New York, 1948, pp. 216-252. E. H. Rieman, *Soap*, 22, No. 10, 135, 153 (1946). J. C. Ward, *ibid.*, 21, No. 9, 117, 127 (1945). J. M. Henderson, *Mod. Sanitation*, 2, No. 6, 16, No. 7, 24, No. 11, 45 (1950).

<sup>18</sup> H. Elishewitz, *Soap*, 23, No. 5, 127, 151; 23, No. 6, 153, 193. (1947). M. E. Parker, *Food Plant Sanitation*, McGraw-Hill, New York, 1948, pp. 170-215. S. A. Rohwer, *Soap*, 23, No. 6, 135, 169, 191, (1947). E. M. Searls, *Milk Plant Monthly*, 27, No. 11, 83 (1948). E. L. Donohoe, *Mod. Sanitation*, 1, No 7, 28 (1949). L. T. Fairhall, *Mod. Sanitation*, 2, No. 2, 26 (1950).

Table continued

*Ind.*, 54, 217T (1935).  
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New York, 1949. A. L.  
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Roe and E. P. Part-  
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protect aluminum from  
attack of alkalis on tin  
fluoride, and some other  
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### 6. Mechanical Aids to Cleaning

Mechanical aids as well as chemicals are required for efficient cleaning operations. Various mechanical aids for cleaning are classified in Table V.

TABLE V  
MECHANICAL AIDS TO CLEANING AND SANITATION

Containers, holders.....	Vats, tanks, tubs, buckets, etc. Racks, baskets, brackets, hooks, etc.
Flushing equipment.....	Sprayers, pumps, hoses, nozzles, compressors, special valves, etc.
Abrasive aids.....	Scrapers, brushes, squeegees, sponges, rags, metal wool, abrasive compounds, etc.
Screens, filters, and traps...	
Machines.....	Agitators, stirrers, pumps, sprayers, tumblers, centrifuges, special washing machines, motor-driven brushes, etc.
Heaters.....	For local water heating, drying, etc.
Moving aids.....	Hoists, elevators, conveyors, trucks, boxes, baskets, racks, etc.
Drying aids.....	Centrifuges, squeegees, towels, fans, vacuum equipment, heating equipment, etc.
Protective aids.....	Aprons, gloves, boots, goggles, etc.

### 7. Degrees of Cleanliness

Cleaning processes cost money. It is only natural, then, to attempt to determine how clean an object need be and when it has reached that degree of cleanliness. Time, material, and labor can be saved by continuing the cleaning process no longer than is needed to give the required cleanliness. There are no absolute and well-established methods of measuring cleanliness, except in a few very specialized fields, nor are there universally accepted standards of cleanliness. Arbitrary standards and methods for judging results are usually devised for each type of operation. These may vary a great deal from plant to plant. In general, however, three degrees of cleanliness may be recognized:

1. Physically clean, *i.e.*, clean to sight and feel. This is the degree least difficult to obtain and most widely desired.
2. Chemically clean, *i.e.*, free of traces of undesirable chemicals (too small to be seen or felt but yet sufficient to influence the quality of the product). Even traces of some chemicals can affect the taste, odor, color, or keeping quality of food products.
3. Microbiologically clean, *i.e.*, free of undesired microorganisms.

All three degrees of cleanliness are important in the food industry. Frequently all three are required to obtain the desired result. In other instances, perhaps only two of these are essential. In practically all cases, however, the first degree, that is, clean to sight and feel, is necessary; and without first having this it is difficult, if not impossible, to obtain the desired degree of chemical or microbiological cleanliness.

There is need for more scientific study and research in connection with the problem of measuring detergency and establishing quantitative standards for cleaning. There are, however, certain general methods which can be applied to the problem of judging the degree of cleanliness achieved in practice. The degree of physical cleanliness obtained is usually estimated by the simple expedient of a close visual

inspection or by feeling. It should be judged in a practical manner. If an object has suffered an adverse effect from contamination from the product, it should be tested by using bacteriological methods. If microorganisms left on the product are coming through, the product is not clean. In some cases the keeping quality and logical cleanliness obtain

#### (a) Water and Water Softening

The most common and important factor in water. As common and well known, to consider certain facts about water supplies furnish water. Water supplies furnish water. Magnesium salts (common in water) which may be detected in Chapter LII. Just how difficult the case will depend upon the materials available, and the

Water impurities are present in water. The most common impurity in water is calcium. The U. S. gallon or in part is equivalent to approximately 17.1 grains per gallon. The present is generally calculated as about 60 p. p. m. used in water which have a hardness is moderately hard. They may be used, they can usually be used. The difficulties encountered in water softening are

It is common knowledge that water softening is especially when ordinary softening is required. Softening is possible which can be made a softening by installing suitable water softening equipment which are not adversely affected by water-softening equipment. The softening process is permitted to overshadow

<sup>20</sup> Note: Water impurities are present in water. Water analysis conversion unit is given in Hodgman, *Handbook of Chemistry and Physics*, 1949, p. 1449.

inspection or by feeling the surfaces with the finger tips. Chemical cleanliness may be judged in a practical way by noting whether or not the quality of the product has suffered an adverse change in color, odor, taste, or keeping quality as a result of contamination from the equipment in question. Microbiological cleanliness can be tested by using bacteriological methods to determine the number and kind of microorganisms left on the object being cleaned or by observing whether the food products are coming through the process with the desired low bacteriological count. In some cases the keeping quality of the product indicates the degree of bacteriological cleanliness obtained.

## 8. Special Types of Detergents

### (a) *Water and Water Softeners*

The most common and most used chemical for cleaning purposes is ordinary water. As common and well-known as water is, it will nevertheless be worthwhile to consider certain facts concerning it in relation to detergency. Most available water supplies furnish water which contains considerable amounts of calcium and magnesium salts (commonly referred to as hardness) and other dissolved substances which may be detrimental to the use of water for cleaning purposes. See Chapter LII. Just how detrimental these substances will prove to be in any given case will depend upon the particular cleaning job to be done, the type of cleaning materials available, and the kind and amount of impurities present in the water.

Water impurities are usually expressed in the United States in terms of grains per U. S. gallon or in parts per million (p. p. m.).<sup>19</sup> One grain per gallon is equivalent to approximately 17.1 p. p. m. The hardness of water (calcium and magnesium) present is generally calculated in terms of  $\text{CaCO}_3$ . Waters having a hardness of less than about 60 p. p. m. usually give little trouble from a cleaning standpoint. Waters which have a hardness in the range of 60 to 120 p. p. m. are usually considered moderately hard. They may often give trouble, but if proper cleaning materials are used, they can usually be used without too much difficulty. As the hardness increases the difficulties encountered due to hardness also increase, so that for real hard waters special cleaners and/or methods must be used to obtain good results.

It is common knowledge that water hardness causes difficulties in cleaning, especially when ordinary soap is used as the detergent, but too few realize the savings which can be made and the improvement in the results which can be obtained by installing suitable water-softening systems or by selecting detergent materials which are not adversely affected by the water hardness. The initial cost of suitable water-softening equipment or the higher cost per pound of some chemicals is often permitted to overshadow the somewhat hidden and less easily calculated savings

<sup>19</sup> Note: Water impurities are also expressed in other units, especially in foreign publications. Water analysis conversion units may be found in various handbooks. See, for example, C. D. Hodgman, *Handbook of Chemistry and Physics*, 31st ed., Chem Rubber Publishing Co., Cleveland, 1949, p. 1449.

which can be made by using soft water or cleaning materials which are especially adapted for hard water use.

There are several water softening processes available. See Chapter LII. The process to be recommended depends upon the type of water and the use to be made of it. The particular process or combination of processes best suited for one plant may not be the proper ones to use at another plant. In many cases satisfactory results can be obtained by softening only the wash water by use of suitable water softening chemicals used along with the detergent rather than softening the whole water supply by one or more of the methods described in Chapter LII. Some of the chemicals best suited for this use, but only available commercially since about 1930, are described below. Prior to then softening in the wash solution was accomplished by certain of the detergent materials themselves. Such chemicals as ordinary soap, soda ash, and trisodium phosphate form very slightly soluble calcium compounds and thus precipitate calcium hardness. In fact, they cannot perform their function as detergents until they have so reacted. Hence, in hard water excessive amounts of these must be added before the cleaning action can begin. These precipitates often tend to adhere to the surfaces being washed, and interfere with the cleaning operation. Hence other methods of softening are desirable.

Occasionally water with low hardness but excessively high total solids may be encountered. For some cleaning purposes such water is not suitable. The excessive dissolved material can be removed by demineralization as described in Chapter LII.

Impurities other than calcium and magnesium may sometimes be present in amounts sufficient to give trouble. From a cleaning standpoint iron compounds are the most troublesome. They can cause staining of equipment and tend to inactivate some sanitizing chemicals. See Chapter LII for information on removal of iron and other impurities.<sup>20</sup>

A special type of chemical<sup>21</sup> for water-treating purposes which has become available only in recent years, is exemplified by such commercial products as Calgon and Quadrafos, which are represented as being, respectively, sodium hexametaphosphate,  $\text{Na}_6\text{P}_6\text{O}_{18}$ , and sodium tetrakisphosphate,  $\text{Na}_4\text{P}_4\text{O}_{13}$ . More recently sodium tripolyphosphate,  $\text{Na}_5\text{P}_3\text{O}_{10}$ , has become available commercially. Tripolyphosphate provides most of the advantage of the hexametaphosphate and the tetrakisphosphate without the disadvantage of being hygroscopic.

These phosphates have the ability to *sequester* the calcium and magnesium ions in such a manner that the ions are not free to react with soap and other detergent materials, and, furthermore, to accomplish this without the formation of precipitates such as are obtained when water is softened by use of soap, sodium carbonate, or trisodium phosphate. It is a well-established fact that in many washing proc-

<sup>20</sup> F. K. Lindsay, *Ind. Eng. Chem.*, 35, 378 (1943).

<sup>21</sup> A. H. Fiske *et al.*, U. S. Pats. 2,019,665-6. B. C. Hafford *et al.*, *Ind. Eng. Chem., Anal. Ed.*, 18, 411 (1946). R. E. Hall, U. S. Pats. 1,956,515 and Re 19,719. G. B. Hatch and O. Rice, *Ind. Eng. Chem.*, 31, 51 (1941). H. Rudy *et al.*, *Angew. Chem.*, 53, 525 (1940). F. M. Scales and M. Kemp, *Intern Assoc. Milk Dealers, Bull.* 22, 589 (1941). C. Schwartz and B. H. Gilmore, *Ind. Eng. Chem.*, 26, 998 (1934).

esses where water, even a film or residue is left on surfaces, organisms and in many cases is undesirable from that standpoint of the water hardness which tends to adhere to the surface of the surface so that the washing is more difficult.

Experiments with the use of these phosphates can prevent the formation of scale. Furthermore, if sufficient quantities are capable of redissolving the scale washings under unfavorable conditions to prevent precipitation in a manner to make the cleaning operation more efficient.

Calgon and Quadrafos are formed by the rapid quenching of glassy material upon quenching ratios of  $\text{Na}_2\text{O}/\text{P}_2\text{O}_5$  low. Glasses may be formed from the melted phosphate. Sodium phosphates.

If the  $\text{Na}_2\text{O}/\text{P}_2\text{O}_5$  is high, sodium pyrophosphate. Tripolyphosphate, or simply pyrophosphate, is a very good dispersing agent for the formation of hard water, even as the polyphosphates.

Pyrophosphate and the dehydrated phosphates, in water in proportion to  $\text{P}_2\text{O}_5$  dehydrated phosphates are used.

More recently certain commercial products under such trade names are a great number of such commercial production. Null-

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Sequestrene A is represented by

<sup>22</sup> U. S. Pats., 2,130,505; 2,2

esses where water, even of low hardness, is used with ordinary cleaning materials, a film or residue is left on the surface. This film can harbor and protect micro-organisms and in many cases builds up to such a thickness as to be visible and undesirable from that standpoint. Such films are apparently caused by the reaction of the water hardness with the detergent material to form precipitates which tend to adhere to the surface. Such films also tend to hold some of the soil onto the surface so that the washing and rinsing process does not effect complete soil removal.

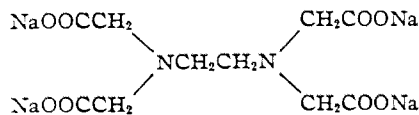
Experiments with these phosphates have shown that, when properly used, they can prevent the formation of undesirable hard water films in the washing processes. Furthermore, if sufficiently high concentrations are used, their solutions are capable of redissolving films which have already been formed as a result of previous washings under unfavorable conditions. Even when used in a concentration insufficient to prevent precipitation entirely, they change the character of the precipitate in a manner to make it less objectionable. They have the ability to prevent crystallization and crystal growth. They also possess good dispersive properties.

Calgon and Quadrafos as commercially produced are in the form of a "glass" formed by the rapid quenching of the melted phosphate. This tendency to form glassy material upon quenching is characteristic of phosphate melts which contain ratios of  $\text{Na}_2\text{O}/\text{P}_2\text{O}_5$  lower than 2:1. Presumably, any number of such phosphate glasses may be formed depending upon the exact ratio of  $\text{Na}_2\text{O}$  to  $\text{P}_2\text{O}_5$  present in the melted phosphate. Such phosphate glasses are sometimes referred to as polyphosphates.

If the  $\text{Na}_2\text{O}/\text{P}_2\text{O}_5$  is 2:1, one obtains a crystalline compound known as tetrasodium pyrophosphate. This product, frequently referred to commercially as TSPP, pyrophosphate, or simply as "pyro," is an excellent detergent material. It is a very good dispersive agent. If the water hardness is not too great, it can prevent the formation of hard water precipitates. It is not so effective in this respect, however, as the polyphosphates mentioned above.

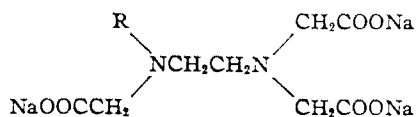
Pyrophosphate and the polyphosphates are sometimes referred to as molecularly dehydrated phosphates, since they are salts of phosphoric acids containing less water in proportion to  $\text{P}_2\text{O}_5$  than orthophosphoric acid contains. These molecularly dehydrated phosphates are finding increased use as detergent materials.

More recently certain organic sequestering agents<sup>22</sup> have become available commercially under such trade names as Nullapon, Versene, and Sequestrene. There are a great number of such compounds which could be made but few are in commercial production. Nullapon B and Versene are represented as being:



Sequestrene A is represented as being:

<sup>22</sup> U. S. Pats., 2,130,505; 2,205,995; 2,240,957; 2,396,938; 2,412,943; 2,412,945; 2,428,353.



where R is an alkyl group.

These agents have certain advantages over polyphosphates in that the complexes formed are more stable, the products are effective at high temperatures and are effective against both calcium and magnesium as well as against many heavy metals such as iron, lead, copper, etc. In contrast to the polyphosphates, their effectiveness increases with increased pH. At present they are much more expensive than polyphosphates so their uses are limited to applications involving high temperatures, high concentrations of heavy metals to be sequestered, or uses requiring long effective life for the solutions where the polyphosphates are unsatisfactory. They do not have the dispersive properties of the polyphosphates

#### (b) Synthetic Detergents<sup>23</sup>

Another type of chemical to be considered for use in hard water is that group of compounds commonly referred to as soapless soaps, wetting agents, surface-active agents, or synthetic detergents (also referred to as surfactants and syndets). Rather than combating hardness, the use of synthetic detergents enables one to more or less ignore the hardness. The calcium and magnesium salts of many of these newer types of surface-active materials are quite soluble, and are not detrimental to the detergent action of the material. There are now a great variety of synthetic detergents available having a wide range of characteristics and uses. In some cases they are used alone, but more often in combination with alkaline detergent salts such as the phosphates, silicates, and carbonates. They increase the wetting and penetrating properties of the solution and in other ways improve its detergent action. The anionic types are most commonly used, although more recently the nonionic synthetic detergents are finding places of usefulness. The cationic materials have been used primarily as germicides rather than detergents, although detergent properties are claimed for some of them. Some have been used as skin detergents for washing hands of food plant workers. There has recently been some use of the quaternary ammonium compounds in detergent preparations for cleaning and sanitizing milking machines and other such dairy equipment.

#### (c) Acid Detergents<sup>24</sup>

The original use of acid materials in food industries was for removing deposits built up by hard water or the combination of calcium and magnesium with detergent

<sup>23</sup> G. E. Barker, *Soap*, 24, No. 6, 46, 65 (1948). F. E. Bartell, *Ind. Eng. Chem.*, 31, 31 (1939). F. M. Scales and M. Kemp, *30th Ann. Rept. N. Y. State Assoc. Dairy and Milk Inspectors*, p. 79 (1939); *Intern. Assoc. Milk Dealers, Bull.* 19, 491 (1941). M. Sittenfield, *Chem. Eng.*, 55, No. 6, 120 (1948).

<sup>24</sup> L. R. Bryant, *Can. Dairy Ice Cream J.*, 25, No. 3, 30, 68 (1946) (has excellent bibliography). F. M. Scales, *Milk Dealer*, 32, No. 2, 30, 64 (1942); *Food Inds.*, 14, No. 4, 51, 97 (1942). M. E. Parker, *Milk Plant Monthly*, 30, No. 9, 48, 67 (1941); *Ind. Eng. Chem.*, 35, 100 (1943).

materials and food soils plants as "milkstone." Inorganic acids such as have been used. Since a should be used in combination their corrosiveness and used, the formation of such corrosive materials eliminated.

Shortly before 1940 an acid in low concentration cans which had been washed such a procedure improved due to removal of the cans after the cleaning the growth of proteolytic action. This led to the development of quality in the products. Apparently the acid rinse and the development of the

From this beginning the further. Such development of synthetic detergents which are detergent action. Because of corrosive effect on metal the acid synthetic detergent

Some of the organic types of microorganisms. Properties of the newer synthetic after the final rinse cern<sup>25</sup> manufactures a special acid detergents. A small each can after which the action of the acid detergent. No alkaline detergent is used.

Acid detergents have been cost of using them they mean means of a portable spray required, spraying will be so easily reached by the equipment which is too large.

Still another method of

<sup>25</sup> *The Story of Conservation*, Lathrop-Paulson, Chicago, 19

<sup>26</sup> Dept. of Public Health private communications. See:

materials and food soils. Such deposits are sometimes referred to in the dairy plants as "milkstone." For this purpose strong acidic action is required. Hence, inorganic acids such as muriatic, phosphoric, or some of the stronger organic acids have been used. Since all of these acids tend to be corrosive to equipment they should be used in combination with so-called "inhibitors" which tend to cut down their corrosiveness and with care. If proper cleaning materials and methods are used, the formation of such deposits can be largely prevented and the need for such corrosive materials eliminated.

Shortly before 1940 another use of acids was made in the dairy industry. Gluconic acid in low concentration was injected into the final steam rinse used for cream cans which had been washed in an alkaline cleaning material. Parker found that such a procedure improved the sanitary quality of the cream cans. This was apparently due to removal of a thin film containing alkali and protein which adhered to the cans after the cleaning process. The alkali-protein film inside the can favored the growth of proteolytic bacteria if the cans were allowed to stand in moist condition. This led to the development of bad odors in the can and off-flavor and poor quality in the products made from cream or milk stored in such containers. Apparently the acid rinse removed or prevented the growth of the proteolytic bacteria, and the development of the odors and off-flavors otherwise encountered.

From this beginning the idea of utilizing acid cleaning solutions has developed further. Such development was made possible by the availability of suitable synthetic detergents which are capable of acting in acid media, and providing good detergent action. Because of the tendency of even mild organic acids to have some corrosive effect on metals, it is common practice to include suitable inhibitors in the acid synthetic detergent solutions.

Some of the organic acids used are capable of inhibiting the growth of many types of microorganisms. A further advantage is that the good surface-active properties of the newer synthetic materials used provide for good drainage of equipment after the final rinse which in turn promotes rapid drying. At least one concern<sup>25</sup> manufactures a special type of can washing machine designed to use only acid detergents. A small fresh charge of acid detergent is sprayed directly into each can after which the can is subjected to spray type washing action with a solution of the acid detergent, then rinsed with very hot fresh water and steam dried. No alkaline detergent is used at all in this system.

Acid detergents have been suggested for other uses. In order to keep down the cost of using them they may be applied to the equipment which is to be cleaned by means of a portable sprayer. In addition to cutting down the amount of solution required, spraying will enable the solution to be applied to areas which would not be so easily reached by brushing and also makes possible the use of the cleaners on equipment which is too large to be cleaned by immersion.

Still another method of using acid detergents has been suggested<sup>26</sup> and is being

<sup>25</sup> *The Story of Conservation Can Washing and Mikro-San Accomplishments*, 2nd ed., Lathrop-Paulson, Chicago, 1948.

<sup>26</sup> Dept. of Public Health, Rockford, Ill., and Klenzade Products, Inc., Beloit, Wisc. private communications. See also C. B. Shogren, *Milk Plant Monthly*, 38, No. 3, 76 (1949).

used to some extent in the dairy industry at present. This is the so-called "alternate" method in which the equipment is washed in the usual manner with a well-balanced alkaline cleaner for several consecutive days (three to six) and then an acid type of cleaner is used for one day. It is claimed that if the alternate method is properly used advantage can be taken both of the stronger cleaning action of alkaline cleaners and the ability of acid detergents to keep the equipment free of film or scale build-up. There appears to be some merit to this approach to the problem. Materials and procedures which will give best results will differ with different plants and require careful study by those experienced in the methods to obtain best results.

#### (d) *Germicides and Microbiological Cleanliness*

Much of the cleaning in food processing plants is for the purpose of obtaining bacteriological and microbiological cleanliness. It is therefore important to consider methods and materials which are useful in reaching that end. Of first importance is the obtaining of thorough physical cleanliness. Physical cleanliness can be obtained, however, without necessarily having bacteriological cleanliness, so it is only natural to attempt to combine some germicidal agent with the cleaning solution in order to accomplish both physical and bacteriological cleanliness in a single operation. Attempts to achieve this result have not been entirely satisfactory, but some progress has been made in that direction in recent years.

One of the simplest methods of obtaining germicidal action during the washing process is to maintain the wash solution at such a high temperature that it can destroy the microorganisms. Such a method can be used for some types of work but there are many cases in which temperatures high enough to destroy the microorganisms are too high to obtain good physical cleaning, are detrimental to the object being cleaned, or are dangerous to the operator. In some cases, too, it is difficult or impractical to maintain sufficiently high temperatures.

Another plan for obtaining microbiological cleanliness along with physical cleanliness is to use a cleaning material which possesses germicidal properties. The widest used application of this idea is in the use of strong caustic soda solutions in bottle washing machines in the milk and carbonated beverage industries. Such highly caustic cleaning solutions are not suitable for all applications, and especially cannot be used where hand cleaning has to be resorted to. Even in bottle washing with strong caustic solutions a chlorine-containing rinse is often used.

Attempts to provide other germicidal detergent solutions suitable for use in the food industries have not yielded promising results. Many chemicals which possess germicidal properties do not function in the presence of the detergent chemicals, nor under the conditions necessary for cleaning. For instance, hypochlorites which, when properly used, give excellent germicidal results are not very suitable for use in detergent solutions for the reason that the available chlorine is quickly dissipated by the soil in the solutions, and by the heat in case high temperatures are used. Furthermore, the germicidal effectiveness of the hypochlorite is markedly decreased

by the high alkalinities and the elements of the cleaning solution could work under the conditions tries because of their position upon the taste, color, or

It has therefore been common and the sterilizing<sup>27</sup> as two physical cleaning followed process is then carried out this sanitizing rinse follows to stand for several hours to subject it to a sanitizing times not necessary to perform often sanitizing action of of the water. In other cases

This separation of the advantage of cutting down sanitizing chemicals need not mean, smaller amounts need

For some operations the in the detergent solution. to a minimum, hence the killed in the rinsing operation but means suggested to do

Certain types of organic ing temperatures, normal to retain sufficient germicid wash solution at a minimum

Considerable progress

<sup>27</sup> Note: To "sterilize" products in industry the term is often used in large proportion of the microorganisms. In recent years the word "sanitized" by removal of or by killing of the particular operation in M. E. Parker, *Food-Plant DuBois, Soap*, 25, No. 5, 137 (1949). W. L. Mallmann, *J.*

<sup>28</sup> G. J. Hucker and W. L.

<sup>29</sup> B. D. Charlton, *Iowa State Schmelkes, J. Biol. Chem.*, 2, 263, 948. I. E. Muskat and *ibid.*, 2, 185, 864. F. T. Peter Schmelkes and H. C. Mark: 323 (1935). A. L. Sotier and *et al.*, *ibid.* 2, 292 (1948). (Barber, *J. Milk & Food Technol.*

by the high alkalinities used, and is sometimes adversely affected by other components of the cleaning solution. Then, too, some germicidal materials, even if they could work under the conditions of cleaning, would not be acceptable in food industries because of their poisonous nature or because of a possible deleterious effect upon the taste, color, or other quality factors of the food being processed.

It has therefore been considered necessary and desirable to consider the cleaning and the sterilizing<sup>27</sup> as two separate processes. The first process should be thorough physical cleaning followed by adequate rinsing with clean water. The sterilizing process is then carried out separately as a separate rinsing operation. Sometimes this sanitizing rinse follows immediately after the cleaning process. If equipment has to stand for several hours after being cleaned prior to use, it is common practice to subject it to a sanitizing rinse immediately before use. If this is done, it is sometimes not necessary to provide a sanitizing rinse immediately after cleaning. Very often sanitizing action of the rinse may merely be that due to the high temperature of the water. In other cases, chemicals may be added to the rinse for this purpose.

This separation of the cleaning and the sanitizing processes has the further advantage of cutting down the cost of the sanitizing chemicals used. Because the sanitizing chemicals need not function under the adverse conditions of the cleaning solution, smaller amounts need be used and cheaper materials can be used.

For some operations there may be an advantage in using a germicidal material in the detergent solution. The bacterial load of the wash solution can thus be kept to a minimum, hence there is less carry-over of live organisms to be removed and killed in the rinsing operation.<sup>28</sup> This idea is more feasible now than in the past, but means suggested to date are far from perfect.

Certain types of organic chlorine compounds<sup>29</sup> are capable of withstanding washing temperatures, normal soil loads, and alkaline washing conditions well enough to retain sufficient germicidal action to keep the number of live organisms in the wash solution at a minimum, even though they may act relatively slowly.

Considerable progress has been made in the last two or three years in the formu-

<sup>27</sup> Note: To "sterilize" properly means to kill completely all microorganisms. However in industry the term is often used in a less strict sense, meaning to remove or kill a sufficiently large proportion of the microorganisms to make the equipment safe from practical standpoint. In recent years the word "sanitize" has come into use to indicate "practical sterilization," either by removal of or by killing of microorganisms to the extent needed to meet the requirements of the particular operation in question. See P. G. Bartlett, *Chem. Ind.*, 64, 215, 318 (1949); M. E. Parker, *Food-Plant Sanitation*, McGraw-Hill, New York, 1948, pp. 239-240. A. S. DuBois, *Soap*, 25, No. 5, 137 (1949). C. K. Johns, *Can. Dairy & Ice Cream J.*, 28, No. 3, 29 (1949). W. L. Mallmann, *J. Milk & Food Tech.*, 13, No. 2, 61 (1950).

<sup>28</sup> G. J. Hucker and W. L. Mallman, *private communications*.

<sup>29</sup> B. D. Charlton, *Iowa State College J. Sci.*, 13, 54 (1938). A. F. Guiteras and F. C. Schmelkes, *J. Biol. Chem.*, 107, 235 (1934). H. O. Halvorson *et al.*, U. S. Pats. 2,138,806; 2,263,948. I. E. Muskat and A. G. Chenicek, *ibid.*, 2,184,883. I. E. Muskat and F. C. Trager, *ibid.*, 2,185,864. F. T. Peters, *ibid.*, 2,422,255. F. C. Schmelkes, *ibid.*, 1,958,370—1. F. C. Schmelkes and H. C. Marks, *ibid.*, 2,016,257. F. C. Schmelkes and E. Strong, *J. Bact.*, 29, 323 (1935). A. L. Sotier and D. B. Conklin, *Food Technol.*, 2, 105 (1948). R. H. Vaughan *et al.*, *ibid.*, 2, 292 (1948). C. B. Wood, U. S. Pats., 1,891,462; 1,894,969; 1,903,525. F. W. Barber, *J. Milk & Food Tech.*, 13, No. 5, 266 (1950).

lation of detergents containing quaternary ammonium compounds.<sup>30</sup> These have been especially successful in a few applications such for instance as in the cleaning and sanitizing of milking machines, cream separators, milk pails, and other such dairy equipment in farm use.<sup>30a,31</sup> Usefulness in other applications is still unproved.

Further information on germicides and microbiological cleanliness will be found in Section II.1e.

(e) *Proprietary Products*<sup>32</sup>

In the tables and discussion above various chemicals have been mentioned which are useful in cleaning and sanitizing operations. It so happens, however, that for most cleaning operations the optimum results cannot be obtained by the use of a single chemical.<sup>33</sup> The use of combinations of properly selected substances mixed in correct proportions to give a cleaning solution which will be best adapted for the particular purpose in mind is required. Some of the larger food processing plants may find it possible to take advantage of these optimum combinations by keeping on hand a supply of all the various raw materials required, and mixing these to suit their special requirements. Generally it is more satisfactory to purchase proprietary materials which have been developed and prepared by organizations which make a special study of the particular types of washing and detergency problems involved. The cost per pound of the better proprietary materials purchased from reliable and progressive firms specializing in this field may seem somewhat high, but the cost of the cleaning materials usually represent only a small fraction of the total cleaning cost. Such savings as can be made by paying slightly less per pound for the detergent usually represents a very small fraction of the total cost and may be entirely insignificant in comparison with the gain which may come from the service rendered by such a firm. Such service, in addition to supplying efficient products and demonstrating how best to use them, may result in the improvement of the various cleaning operations so as to cut down on the total time and labor involved. It may also bring about a reduction in losses commonly caused by damage to equipment and spoilage of food batches when wrong cleaning materials or methods are used. The advantages to be gained from these services should not be overlooked. Sometimes the cost of materials used will actually be less if the food manufacturer avails himself of such services than if he attempts to do the job without expert advice by using materials not properly selected for the requirements.

<sup>30</sup> P. G. Bartlett, *Chem. Ind.*, 64, 215, 318 (1949). F. W. Barber, *J. Milk & Food Tech.*, 12, No. 5, 257 (1949). P. R. Elliker *et al.*, *J. Milk & Food Tech.*, 13, No. 4, 215 (1950). G. R. Goetchius, *Chem. Ind.*, 65, No. 4, 560 (1949). G. J. Hucker, *Proc. 41st. Ann. Conf. Milk & Food Found.*, 2, 44 (1948). R. G. Puhle, *Soap*, 26, No. 12, 133 (1950).

<sup>30a</sup> Rohm & Haas Co., *private communications*.

<sup>31</sup> G. J. Hucker, W. L. Mallman, *et al.*, *private communications*. also *Rohm & Haas Reporter*, 7, No. 4, 1 (1949).

<sup>32</sup> M. E. Parker, *Food Inds.*, 15, No. 7, 78, 135; No. 8, 71, 131; No. 9, 66 (1943).

<sup>33</sup> I. I. Somers, *Food Inds.*, 21, No. 3, 72, 206 (1949).

A wise choice of the selection of a number of factors

1. The particular cleaning method to be employed in

2. The cost. Cost is in which to judge the value the cost per pound of id then cost should not be The real cost angle to be job which is to be done. the labor, the cost of other aids. Furthermore, the results obtained must be if one is to have a sound

3. The source of supply equal quality of cleaning of the supplier depends on he will render, and the cost immediately but over a period employees to do an efficient with different cleaners will materials as infrequently as which give the desired result ing a supplier is important firm which is progressive become available from time which it covers.

The detailed method described only on the basis at the time and place where circumstances will vary much plant.

It is possible, however, in mind in selecting the method

One should take note of of equipment to be cleaned

<sup>34</sup> H. G. Harding and H. A. *Plant Sanitation*, McGraw-Hill

<sup>35</sup> Parker, *loc cit.*, p. 298-329

THE FOLLOWING PAGES ARE FROM:

**"ENGINEERING FOR FOOD SAFETY  
AND SANITATION"**

by THOMAS J. IMHOLTE

TECHNICAL INSTITUTE OF FOOD SAFETY, INC., 1984

ISBN 0-918351-00-6

# CHAPTER CLEANING 8

## CHAPTER CONTENTS

WET CLEANING

CLEAN-OUT-OF-PLACE  
(C. O. P.) SYSTEMS

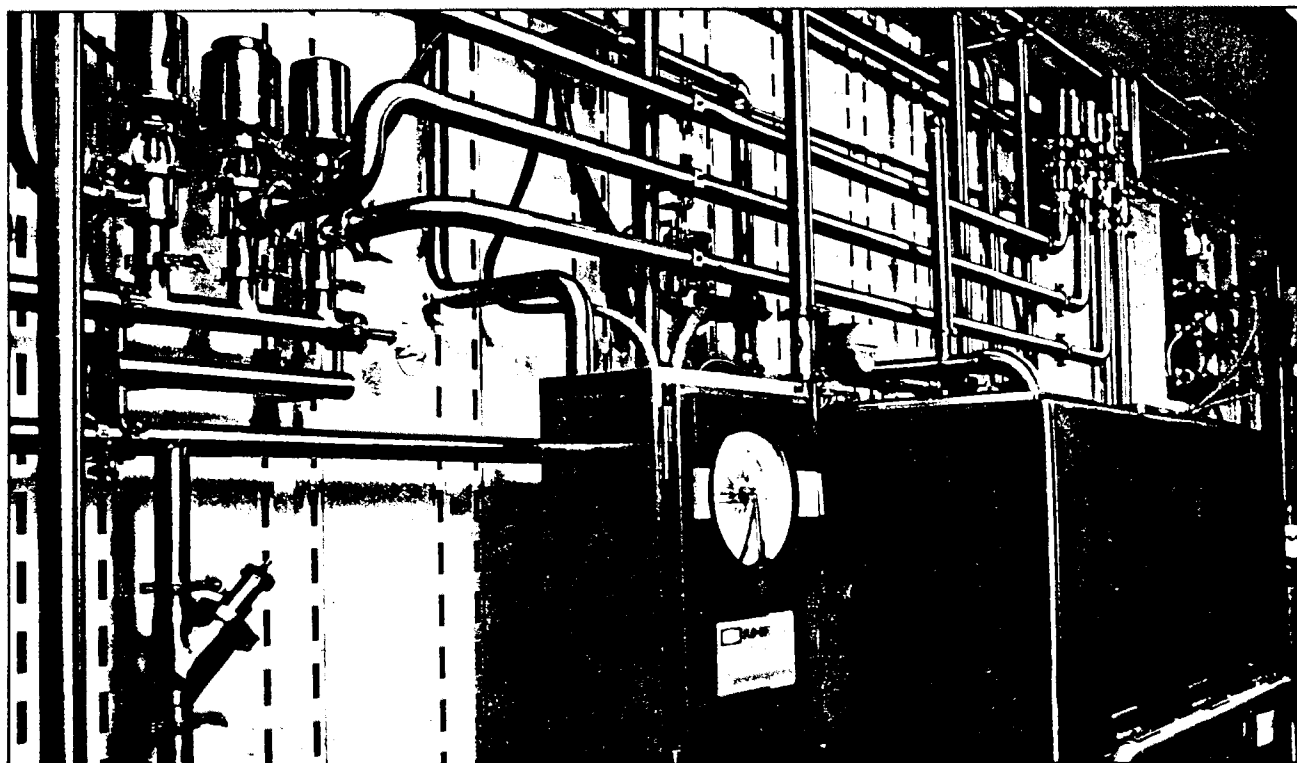
CLEAN-IN-PLACE  
(C. I. P.) SYSTEMS

CENTRAL CLEANING SYSTEMS

INDIVIDUAL HOT WATER HOSE STATION

DRY CLEANING

Just as a great many economic benefits result from the sanitary design of buildings and equipment, economic benefits also come from the careful planning of a cleaning system. A good design can greatly reduce cleaning costs and at the same time vastly improve the quality of cleaning. To accomplish this, it is necessary to define the cleaning job and then select the right cleaning system to get it done. Technological advances in cleaning equipment and cleaning materials will make this process easier.



Because it sometimes seems difficult to justify the capital investment required for various cleaning systems, it is important not to overlook possible productivity improvements. Properly applied, cleaning systems get the cleaning job done faster, putting the manufacturing system back on stream more quickly. This results in optimum case outputs and reduces the need for overtime wages. Cleaning functions can be productive!

In Chapter One we discussed the importance of linking the sanitary design requirements to the type of risk a specific food product represents. Likewise, the cleaning requirements must also be linked to this risk. Some food manufacturing systems are very sensitive to microbial problems and must be thoroughly wet cleaned and sanitized on a frequent schedule. Some systems are basically dry processing systems; in the interest of minimizing microbial risk, they should be dry cleaned. Then there are those that will require dry cleaning and wet cleaning because of the nature of the process or the stickiness of the ingredients.

## WET CLEANING

Wet cleaning is a science which includes the chemistry of cleaning and the proper application of cleaning equipment. The chemistry of cleaning involves the proper selection of chemicals and the quality of water. In this chapter we will not discuss cleaning chemicals. This subject is covered in many food sanitation texts. However, you should be aware that many different types of dirt and surface film collect on many different food manufacturing equipment surfaces. The proper selection of cleaning chemicals can save many cleaning hours and improve the quality of the cleaning job dramatically.

The proper application of cleaning equipment begins with becoming familiar with some of the various cleaning systems and retrofitting them to the cleaning task as required. Wet cleaning systems experts have more or less adopted a language of their own, and specific terminology is used to define the system. Some of the more common systems are:

- Clean-out-of-place systems—C. O. P.
- Clean-in-place systems—C. I. P.

- Central cleaning systems—C. C. S.
- Hose stations

Each of these systems has a number of advantages. In most cases they generally offer a high quality of cleaning and cleaning economics. Remember that it is important to understand the basic cleaning principles involved so you can put them to work—and so you can retrofit them! These principles are discussed in more detail in the sections that follow.

## WATER QUALITY

It goes without saying that cleaning water must be of potable quality. In addition, of course, the water must be soft. Hard water greatly reduces the cleaning action of many detergents. Hard water in itself can create a number of surface scale or surface film problems such as rust formations or calcium deposits. An effective cleaning program must have an adequate supply of soft, hot water. Conditioned water reduces the corrosive effects of hard water and extends the economic life of plumbing systems as well as that of many other pieces of equipment using water. Many efforts have been made to classify water hardness. The U. S. Geological Survey Water Supply Paper number 658 classifies hardness as follows:

- Soft. 0-3.5 grains/gallon
- Moderately Hard. 3.5-7.0 grains/gallon
- Hard. 7.0-10.5 grains/gallon
- Very Hard. Over 10.5 grains/gallon

## CONDITIONING EQUIPMENT

The plant water treatment system should include zeolite and dealkalizing equipment where water quality requires it. Sodium zeolite softening is the most common conditioning system. The primary purpose of conditioning is to remove scale-forming calcium and magnesium ions, which are constituents of hard water. Dealkalizing equipment reduces the alkalinity of the treated water and the subsequent formation of carbon dioxide in the steam. This reduces steam and condensate line corrosion as well as excessive boiler tube scaling. Corrosion is a compounding steam

## CLEANING

impurity problem when steam is used in direct contact with the food product.

### WATER TEMPERATURE

There are many opinions about the correct temperature for cleaning water. Whereas there may be an application or two for exceptionally hot water (165° to 200°F), generally speaking, water at 110° to 145°F is more than adequate. In fact, many detergents are most effective in the presence of warm water. Extremely hot water can set or fix soil to the surface which is to be cleaned.

## CLEAN-OUT-OF-PLACE (C. O. P.) SYSTEMS

Clean-out-of-place systems do exactly what the term suggests, cleaning out of place. Essentially, this means moving equipment from its normal location (and/or disassembling it and removing it from its normal location) for cleaning. The removed equipment or components are generally taken to a cleaning room that has been specially designed and equipped for cleaning out of place. This room is sometimes used to clean utensils, portable equipment, trays, and pans as well.

### CLEANING ROOM

The equipment cleaning room should be constructed of moisture-impervious materials that are easy to clean. (*Figure 8-1*) Use design criteria that meet requirements for a wet cleaning area. Make sure the room is large enough to accommodate the largest piece of equipment likely to be cleaned in it.

**Building Materials for Cleaning Room.** Construct walls, ceiling, and floor of materials that can be easily wet cleaned. Use ceramic or glazed tile for the walls and ceilings. Floors should be quarry tile or acid-proof brick, including epoxy grouting mixtures.

Provide adequate lighting approximately 80-100 foot-candles and use lighting fixtures suitable for wet areas. Install at least two 110-volt NEMA 4 receptacles for electricity. The floor should have a floor drain (complete with grate, screen, and trap) and should slope to the drain at the rate of 3/16 inch per foot.



FIG. 8-1 This equipment cleaning room features building materials which are impervious to moisture and the proper cleaning equipment to get the *clean-out-of-place* accomplished as easily as possible.

In the wash area, use double or single doors, made of metal or rubber. (Do not consider using wood.) The doors must be wide enough to allow clearance for the largest piece of equipment to be cleaned.

The room will need an exhaust fan to expel steam vapors. Drip legs with shut-off valves should be installed in the fan and exhaust ducts to drain off accumulated condensate.

**Equipment for Cleaning Room.** The cleaning room should have a large, deep-well utensil cleaning sink constructed of stainless steel. The sink should be equipped with a water mixing valve supplied with an adequate quantity of hot and cold water. (*Figure 8-2*) Mount a separate hose cleaning station on the wall in a convenient location. (This station may be part of, or similar to, the stations described later in this chapter under Central Cleaning Systems.) Depending on your preference, it may be either a high-pressure, low-volume system or a low-pressure, high-volume system. Since the room is specifically designed for wet cleaning you might find a low-pressure, high-volume system more useful. The room should also have a separate wall-mounted sanitizing

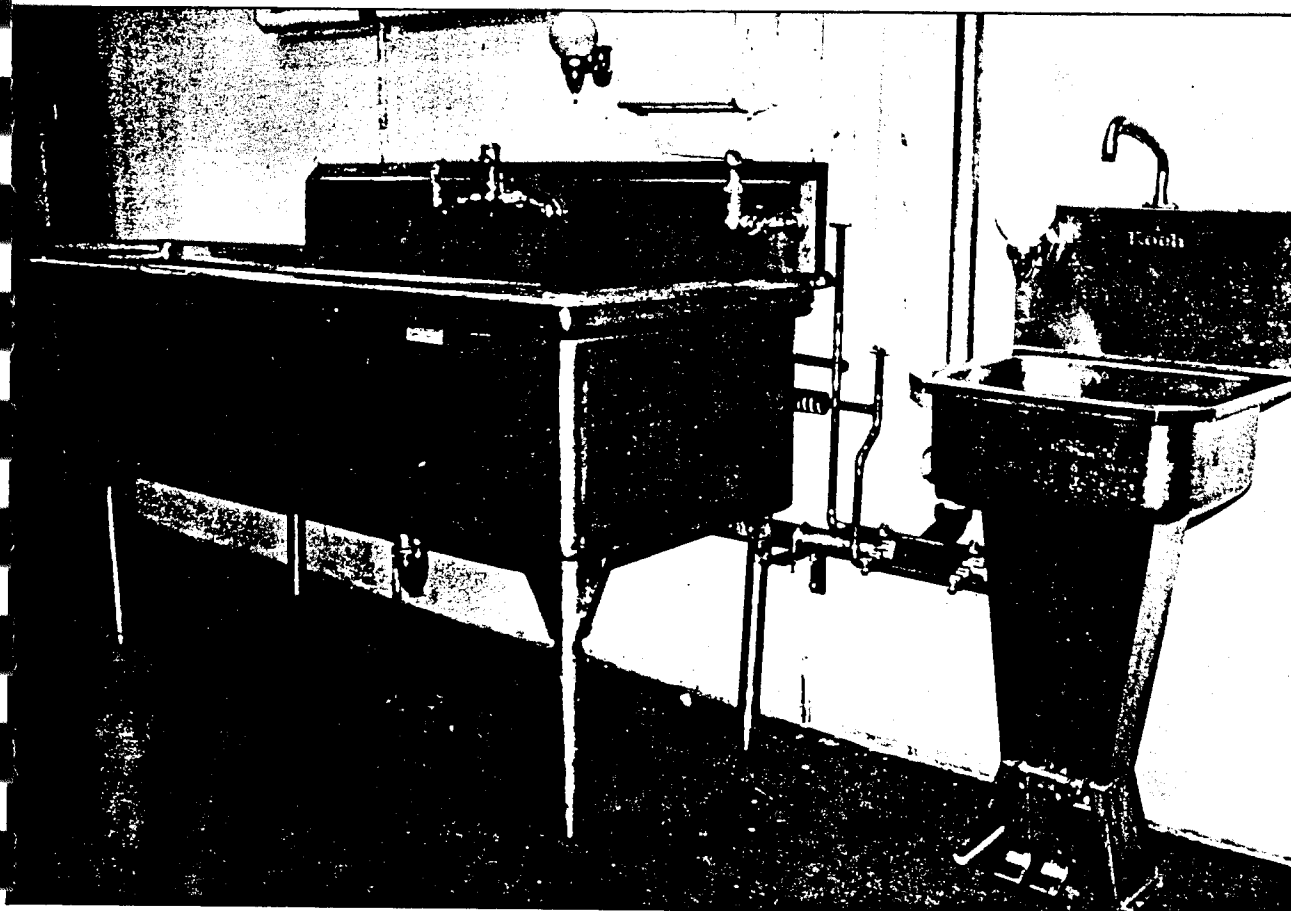


FIG. 8-2 Large deep-well stainless steel sinks are used for utensil cleaning.

station with a water supply and a self-contained spray sanitizing unit. (Figure 8-3) These units are designed to draw predetermined amounts of concentrated sanitizing solutions into the water stream. Equip the station with an adequate length of hose complete with an automatic shut-off type nozzle. Backflow prevention equipment should be provided on potable water supply lines. A portable wet vacuum unit would be useful for this area as well.

Shelves, wall hangers, and drying racks provide space for cleaned utensils. Detergents, wiping towels, and other supplies can be kept in storage cabinets. Waste receptacles are also necessary.

Food manufacturing operations requiring a lot of disassembly of smaller equipment parts for out-of-place cleaning would benefit from equipping the cleaning room with a specially designed recirculating tank-type washer. (Figure 8-4) Recirculating tank washers have a series of turbo-action jet nozzles and a high-efficiency stainless steel

pump to circulate the water. Detergents are added and cleaning takes place as the water flows turbulently through the tank. Parts to be cleaned are set in the tank and left until they are clean. Constructed of heavy-gauge stainless steel, the tank must be of sufficient size to accommodate the largest components intended to be cleaned. Specially designed stainless steel baskets permit cleaning of smaller parts. Important tank construction details are rounded corner junctions, automatic temperature regulating equipment, direct-reading thermometers, strainers on the water inlet, and valves to drain the tank. Optional equipment may include a chemical feed system and a heat exchanger for heating the water.

Recirculating tank washers can be purchased from manufacturers specializing in the design of this equipment or they can be designed by most food plant engineering departments.

## CLEAN-IN-PLACE (C. I. P.) SYSTEMS

Clean-in-place systems can be used to clean process piping systems, bins, tanks, mixing equipment, or larger pieces of equipment in place (without disassembly) where interior product zones are fully exposed and soil can be readily washed away by the flow of the cleaning solution. (Figure 8-5) These systems use high volumes of water to literally wash away the soil. The success of the system is keyed to proper water flow, temperature, and selection of the right cleaning chemicals. If the equipment being cleaned has been correctly designed in the beginning, this method can do a better and quicker job of cleaning than standard methods, and a great deal of time and effort can be saved. Designs for C. I. P. systems range from very basic manual or semi-automatic recirculating spray systems to highly sophisticated and fully automated systems for cleaning bacteria-sensitive process piping systems, depending on your needs.

### RECIRCULATING SPRAY CLEANING

When bins, tanks, mixers, or similar equipment are to be C. I. P. cleaned, spray cleaning is involved. Successful spray cleaning applications require a properly designed spray assembly with a constant water flow at the required pressure and temperature. Spraying assemblies that consist of spray balls or nozzles can be stationary, water driven, electric, or air propelled. These units may be permanently installed in the equipment or they may be portable and put in place at the time of cleaning. The spray assemblies must be designed and located to assure that the cleaning solution contacts the entire surface to be cleaned. (Figure 8-5) The minimum C. I. P. solution circulation rate should be 10 gallons per hour (GPH) for each square foot of surface to be cleaned. Large-size storage tanks having a capacity of 3,000 gallons require a minimum cleaning solution circulation rate of 4,000 GPH.

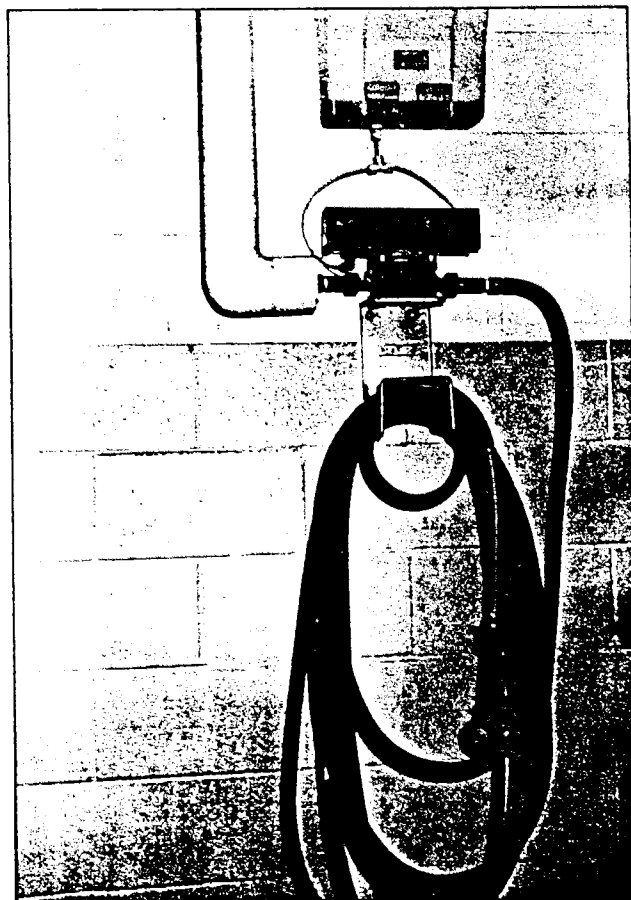
The use of recirculated spray cleaning techniques really begins with the design of the process equipment. Bins, tanks, mixers, or other equipment which is to be spray cleaned should be designed with spray cleaning in mind. Equipment components such as access doors, sight glasses, temperature wells, mixer blades, inlet and outlet connections should be designed and located so they, too, can be cleaned by the sprayed solution.

The primary element to the C. I. P. system is the recirculating equipment. This consists of a solution tank,

centrifugal pump, and a series of valves which are normally air operated. (Figure 8-6) Cleaning chemicals can be injected into the water stream or added directly at the recirculating tank. Steam is introduced into the water to heat and maintain predetermined water temperatures through temperature sensing probes and control valves located in the system. A typical C. I. P. spray cleaning cycle would consist of:

1. Pre-rinse cycle
2. Wash cycle
3. Post-rinse cycle
4. Sanitize cycle

FIG. 8-3 Wall-mounted, spray-type sanitizing units should be included in every equipment cleaning room.



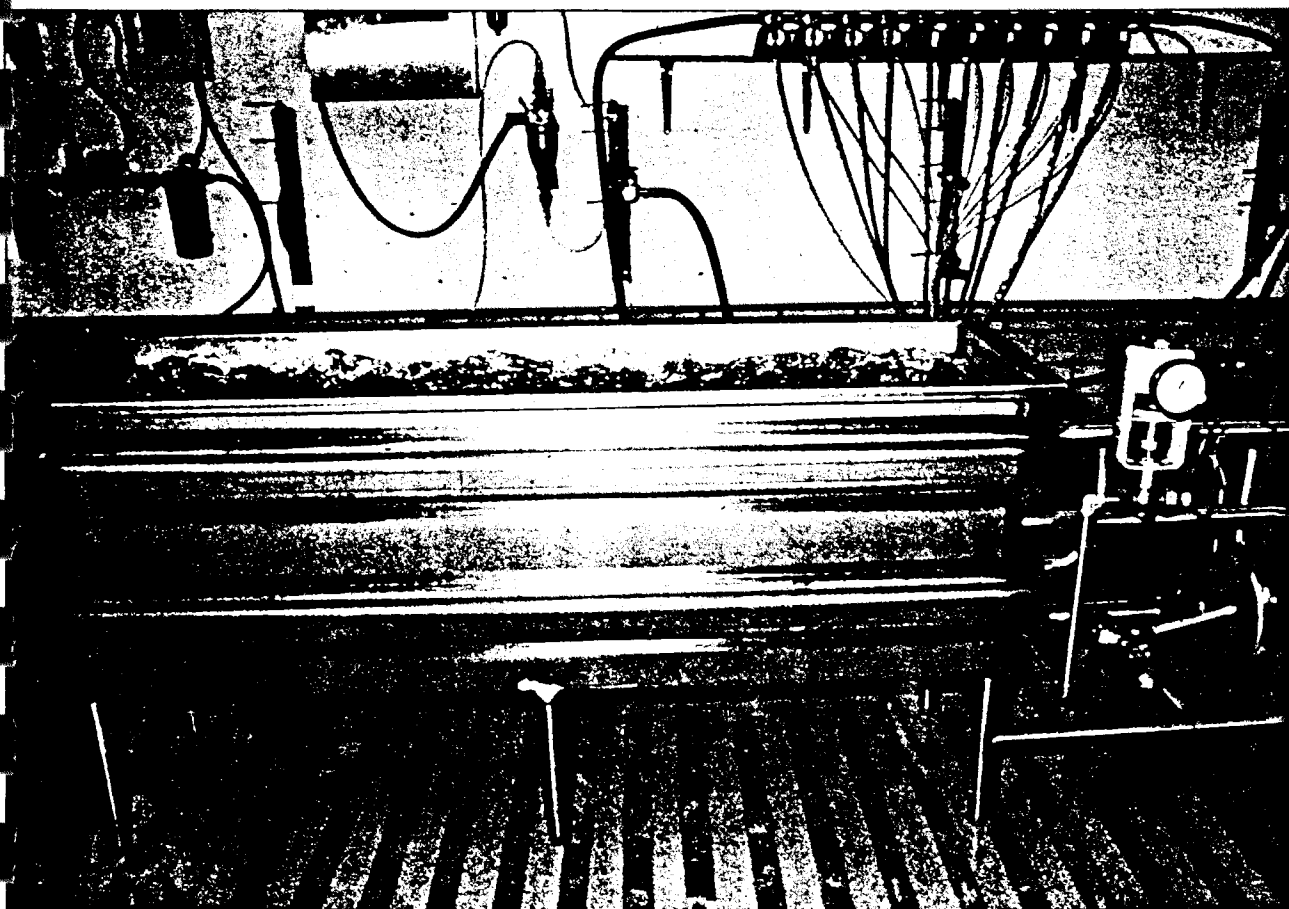


FIG. 8-4 The turbulent cleaning action of the water in *clean-out-of-place* tanks can clean small parts with little effort.

All cleaning operations begin and end at the primary recirculating unit. A centrifugal return pump moves the solution back to the recirculating unit where it is either placed back in the tank or directed into the drain. To minimize pump cavitation, the pump should be equipped with an air vent. The line to the suction side of the return pump should be adequately sized so that it does not restrict the return solution flow, as this can also cause cavitation.

The recirculating package can be permanently installed or mounted on wheels so that it can be moved. The system can be fully automated to perform rinse, wash, and sanitizing operations by adding a control panel to the unit. Supply-return piping can also be permanently installed if there are a number of cleaning applications in a given area.

Tanks or equipment to be spray cleaned must be properly vented to prevent them from collapsing from a vacuum condition that can occur when a cold water rinse follows a hot cleaning cycle. It is very important to provide

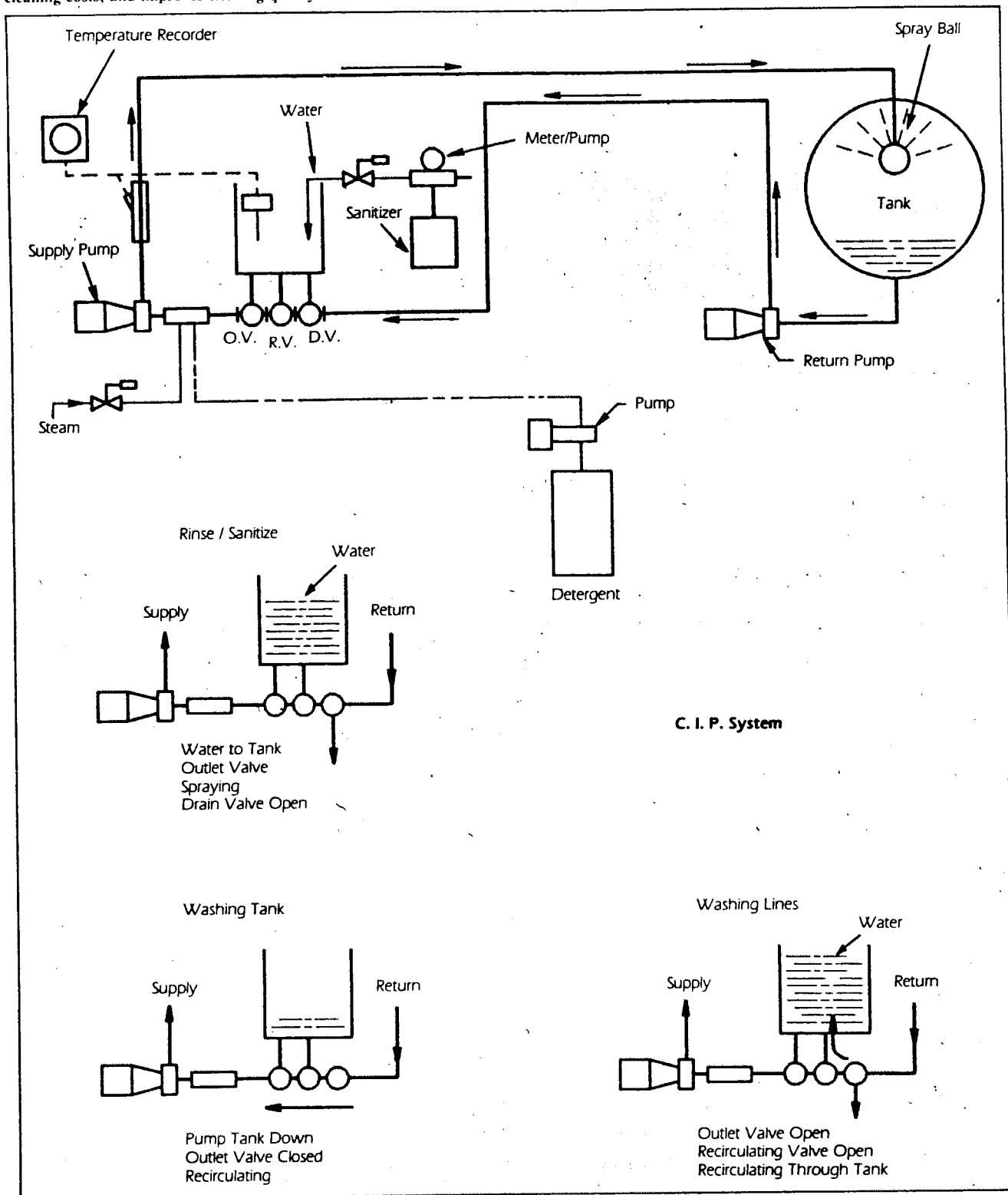
vents that are the right size. The 3-A Dairy Standards for Storage Tank Design can be helpful in determining vent size, which in some instances might require a man-sized or larger access opening. Vents must also be designed to open before the cleaning cycle begins. It is important to remember that whereas properly designed and vented round storage tanks will withstand most vacuum conditions, square or rectangular tanks might not. This is because it is somewhat difficult to design square or rectangular tanks that will resist collapsing in vacuum situations. Recirculating spray systems are effective cleaning systems that make good use of water and chemicals through the recirculating feature. There are many applications for this cleaning approach in almost every food plant.

#### **AUTOMATIC CLEAN-IN-PLACE FOR PROCESS PIPE SYSTEMS**

Widely used in the dairy industry for many years, this system automatically controls all the variables of a mechanical

# CLEANING

FIG. 8-5 A typical clean-in-place (C. I. P.) cleaning system used for liquid line or tank cleaning is shown. C. I. P. cleaning reduces cleaning costs, and improves cleaning quality.



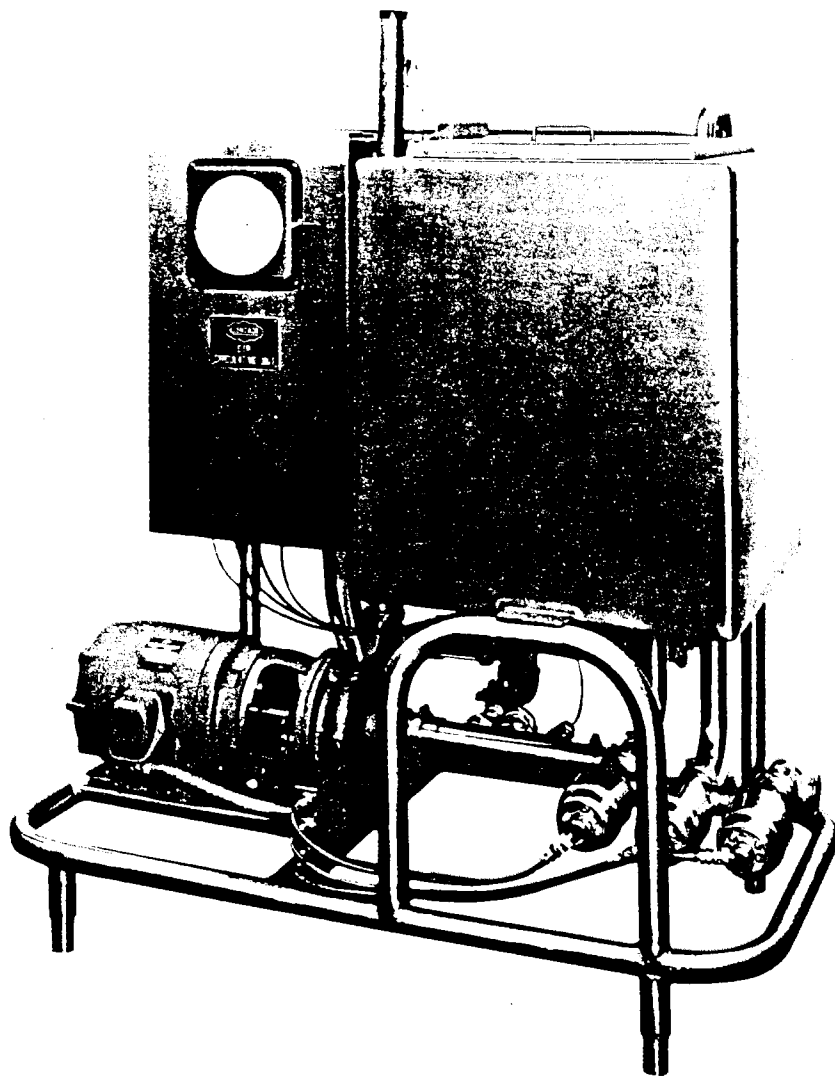


FIG. 8-6 The major components of a C. I. P. system are the recirculating tank, pump, and automatic valves.

cleaning process, including time, temperature, and chemicals. It is a highly specialized system, engineered to control the physical actions of the cleaning process. Automatic clean-in-place is used to clean some permanently installed equipment and process piping systems with little or no disassembly of the equipment. The controlled cleaning cycle generally consists of a pre-rinse, a detergent wash, a post-rinse, and a sanitizing step. The cleaning action is controlled by the pumping rates and velocities of the various solutions, as well as by the selection of chemicals. A fully automatic recirculating system permanently located in a designated area is used as the primary unit, and each clean-in-place

cycle is timed and programmed into the central recirculating control console.

**System Design.** Automated clean-in-place design begins with the development of the circuits to be cleaned, the selection of a recirculating unit, and the development of a cleaning program that will get the equipment clean. The system must be designed so that all surfaces are effectively contacted by the cleaning solution.

Layout of the C. I. P. lines for processing functions involves using both the process lines and the cleaning solution lines effectively. (Figure 8-7) The object is to switch

from the processing mode to the cleaning mode with the least number of crossover connections and without bypasses which would make manual cleaning necessary for some parts of the system. It is also important that there be no dead ends, and the pipe be properly pitched toward the return lines to assure complete drainage. A pitch of one inch in ten feet should be considered, and for the most part should not be less than one inch in twenty feet. All piping should be well supported. It is best to provide supports on approximately ten to fifteen-foot centers so that there are no sags for solutions to lie dormant, and to place pipe supports adjacent to air-operated valves. Include expansion joints, as many C. I. P. systems will use hot water at 165°F. For a temperature rise of 100°F, the expansion could be approximately one inch in 1,000 lineal feet of pipe.

Process and return piping systems should be designed with sanitary pipe and fittings that meet the requirements of the 3-A Dairy Standards and are C. I. P. cleanable. Processing and return systems may also be designed with welded pipe. Modern welding techniques make it possible to achieve very smooth, crevice-free interior welded joints which are easily cleanable. Welded piping systems should have occasional sanitary union connections so that lines can be taken apart and inspected.

**Recirculating Equipment.** Recirculating equipment will be similar, if not identical, to that used for recirculating spray cleaning. It will consist of solution tanks, pump, and a series of automatic valves. Recirculating solution tanks vary in size from 160 to 350 gallons. The size and number of tanks required are based on the size of the total C. I. P. system. The solution tank must be large enough to provide the pump with a constant supply of hot water, and it must serve as a place for introducing detergents and sanitizers into the system. The unit will be fully programmed to complete all phases of the cleaning operation—the pre-rinse, wash, post-rinse, and sanitizing steps—in a timed sequence.

The physical action of the cleaning operation is greatly influenced by the rate of flow and the velocity of the solution. A velocity of five feet per second is considered to be ideal for cleaning process piping. C. I. P. pumps should be stainless steel centrifugal units carefully chosen to meet design conditions. Pump performance is important if the system is to operate satisfactorily. Fully automatic C. I. P. systems can fit the cleaning needs of the dairy process as well as those of many other food processors.

C. I. P. systems should be given serious consideration because they will do a thorough cleaning job in the least amount of time. One most important C. I. P. design consideration, however, is to make certain that the basic design includes fail-safe features that will prevent cleaning solutions from contaminating food products in process or storage when adjacent equipment is being cleaned. For example, if tank 'A' is empty and adjacent to tank 'B', which is full of a food liquid, an error made while spray cleaning tank 'A' could cause the cleaning solution to enter tank 'B' and contaminate the entire food contents.

## CENTRAL CLEANING SYSTEMS

In central cleaning systems, a supply of hot water is piped to a number of cleaning stations placed strategically throughout the manufacturing area. Cleaning chemicals can also be pumped from a central make-up system to these stations, or if preferred, fed directly into the hot water supply at each cleaning station. Central systems can be designed as low-pressure, high-volume systems or high-pressure, low-volume systems; if needed, they can also be high-pressure, high-volume systems. Each design offers some advantages for different types of cleaning problems. It is fairly well accepted that the cleaning quality is directly proportionate to the quantity of water used. Many cleaning jobs involve bacteria-sensitive products and somewhat difficult-to-remove soils. These jobs are best done with low pressure and high volumes of water, in which case the soiled surfaces are cleaned by a larger amount of water flowing over them. Extremely stubborn soils which cling or stick to surfaces and resist removal may be more easily removed by a high-pressure, high-volume system. The high-volume feature of a high-pressure system adds impingement or striking force due to the mass and weight of the additional water. Nine to twelve gallons per minute (GPM) or higher is considered high volume.

Most cleaning problems, however, fall into the category of *difficult-to-remove soils with a tendency to stick to almost any surface*. These soils can generally be removed with a high-pressure, low-volume system. High-pressure, low-volume systems operating in the 600 to 800 psi ranges and delivering three to five GPM at each station have been accepted by many segments of the food industry. These

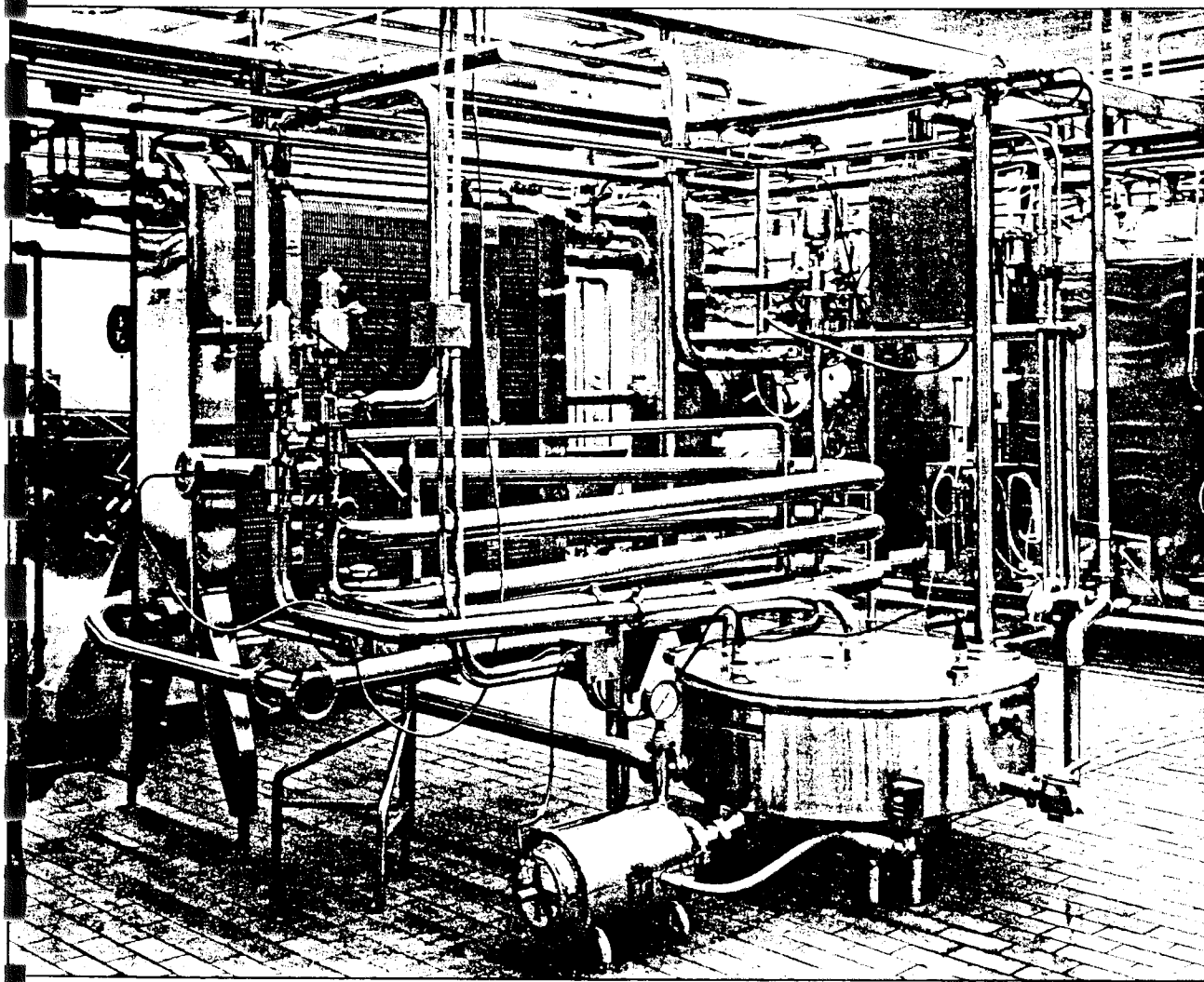


FIG. 8-7 C. I. P. system design effectively utilizes the process liquid lines and cleaning solution lines to minimize bypasses and crossover connections.

systems have a number of advantages: they use less water, resulting in energy savings; the low volume of water can often be managed with a wet vacuum in a drainless area; they represent less of a maintenance threat to equipment subject to damage by large quantities of water; and they do a high-quality job of cleaning most surfaces.

Central cleaning systems provide a unique and quick way to assure an adequate supply of hot water for all areas requiring it. Central systems are used to clean equipment, walls, floors, and ceilings. There is very little that these systems cannot clean—they can remove even the toughest oil. Combined with the proper cleaning and sanitizing chemicals, central cleaning systems are both efficient and effective.

### SYSTEM DESIGN

There are several types of central systems. Some systems have both a hot water supply and a central chemical distribution system which supplies the water and the chemicals to each cleaning station where they are blended together through a flow control valve and a mixing valve. (Figure 8-8) Another system offers hot and cold water in addition to a central chemical supply. Still another system provides hot water with chemical additions from an individual injector system at the cleaning station. (Figure 8-9) Each of these systems has something to offer. Features should be selected on an *as needed* basis. However, remember that most cleaning tasks will require a pre-rinse, a wash, a post-rinse, and a sanitizing step. Also, it is hard

to do without the convenience of being able to add or omit chemicals as desired at the cleaning station.

### SIZE AND LAYOUT

The size of the system will depend on the total number of stations and—most importantly—the total number of stations that will be operating at any one time. The total number of hoses to be used at one time coupled with the flow rate at each station determines the size of the pump and/or the number of pumps needed. The location of individual stations is obviously determined by need, but each station should be convenient to the equipment and areas it will clean. A station should be three to five feet off the floor, and there should be ample room in the immediate vicinity to operate and service the station.

Water and chemical lines should be installed in such a manner that they themselves do not create a sanitation problem. Insulate the hot water line, and if a central

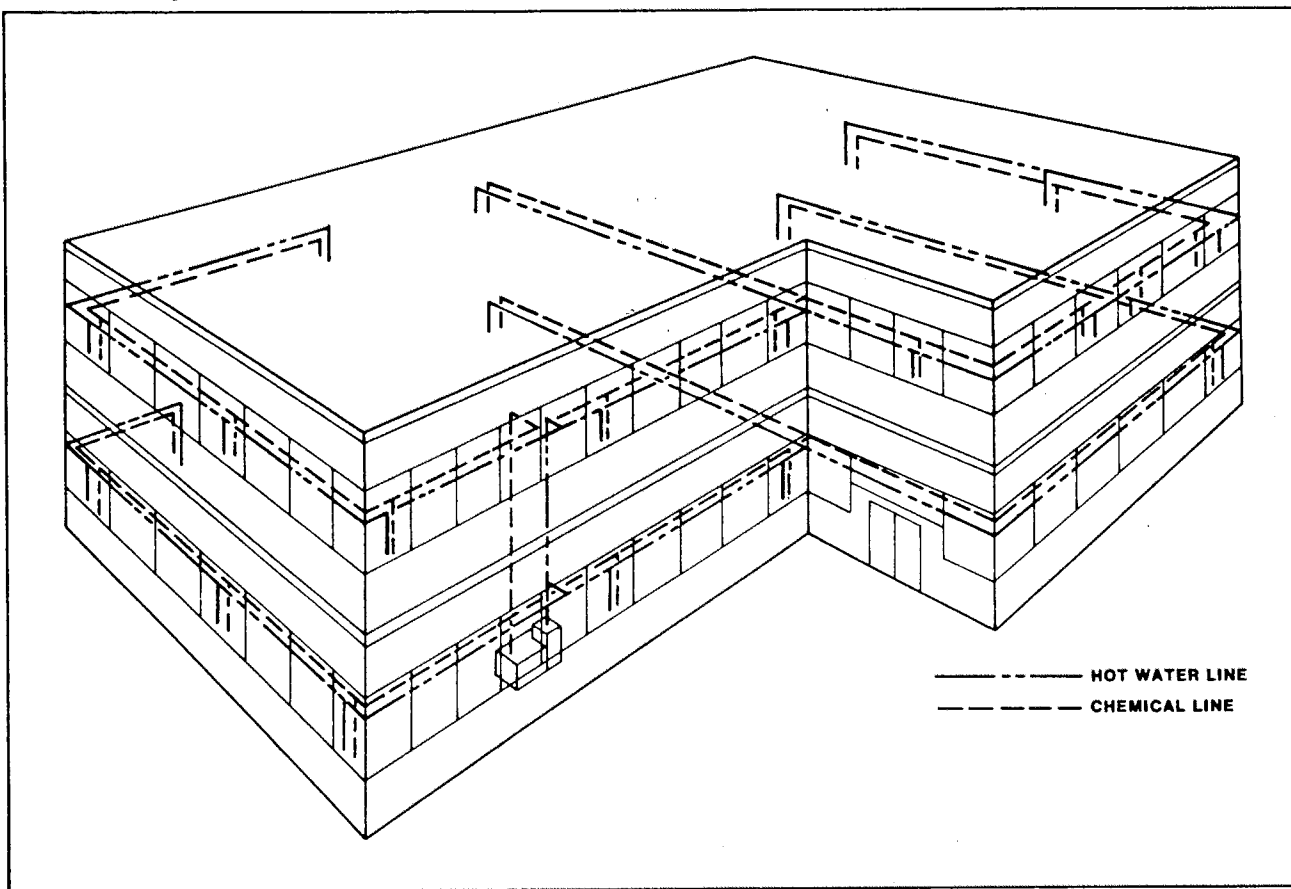
chemical distribution system is used, identify the chemical lines. Make sure the pipe lines are the proper size for carrying the needed quantities of water and chemicals at the required pressure.

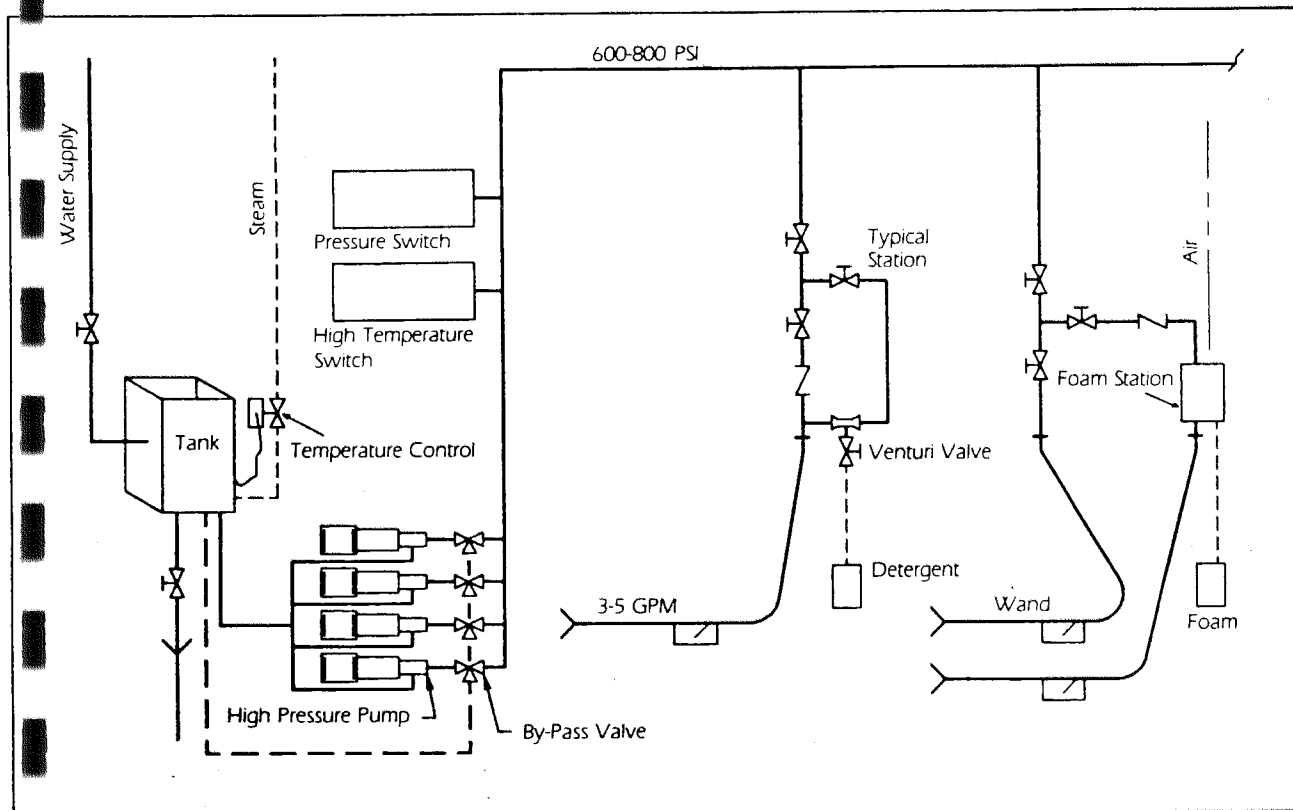
### PUMPS

The heart of a central system is the pump or pumps. One kind of pump is the centrifugal pump, which is normally used on low-pressure systems. Sometimes a centrifugal pump functions as a distribution pump for a high-pressure system, and the high-pressure pump is used at the cleaning station as a booster pump. A centrifugal pump should be sized to accommodate the required water needs. In cases where the pump moves water containing cleaning or sanitizing chemicals, the pump should be constructed of stainless steel.

In small-to-medium sized high-pressure, low-volume cleaning systems, a positive displacement piston pump is

FIG. 8-8 Cleaning system with central chemical distribution system





G. 8-9 Central cleaning system with individual use point chemical system

often the main distribution pump. Piston pumps are also used as booster pumps at individual cleaning stations. In a medium-sized system that is designed to run intermittently or that runs at something less than full capacity of the system on occasion, a group of two to four piston pumps may be staged together as a main distribution pump system to better satisfy the capacity variables of the system. Positive displacement piston pumps displace given quantities of water. If all of the water is not being used at the cleaning stations, it must be bypassed back to the supply source. The advantage of a multiple pump system is that only those pumps required to fulfill the immediate water supply requirement have to run. Other pumps are phased in on a demand basis.

Multi-stage centrifugals or jet pumps are used on medium-to-large size central systems as the primary distribution pump. These pumps not only satisfy the requirements of the higher pressures, but they can provide larger quantities of water from a single pump. Multi-stage centrifugals or jet pumps are normally used on systems that are designed to run continuously rather than on an intermittent

basis; frequent starting and stopping can damage large pumps and motors.

High-pressure pumps should be considered for heavy-duty applications. All high-pressure pump installations should feature protective devices, including bypasses or pressure cut-out switches to protect the pump from damage. At one time or another any system is likely to operate at less than the designed capacity, and pump protection is needed accordingly. Filters or strainers on the water supply will protect the pumps from any particles that find their way into the water. Also, install accumulator-pulsation dampeners on piston pump systems or any other system subject to fluid shock. Place the dampeners as close to the pump as possible to avert shock damage to the pump.

Neoprene or rubber pump seals are sometimes affected by high temperatures (approximately 160°F) and should be protected by high temperature cut-out switches. Because detergents will also affect seals, add them downstream of the pump discharge. Some pumps require the water supply pressure to be controlled to protect the seals; and, in such cases, place pressure regulators and

pressure cut-out switches on the suction side of the pump.

The pump electrical circuit should be designed so that the pump protective devices cannot be bypassed, such as with a hand/off/automatic switch. If a hand running position is desired for maintenance purposes, consider a specially keyed switch. For multi-state piston pump systems, include a sequence switch which will permit a change in the starting sequence lead pump. Without this, the number one or two pump will have many more running hours which could increase maintenance costs and result in more system failures.

### CLEANING STATIONS

The desirable features at a typical cleaning station will vary with the basic design of the pumping system. For systems using a central centrifugal distribution pump and a booster pump at the cleaning hose station, the station should include a start/stop switch for the booster pump and pilot lights to indicate if the pump is running. All stations need clearly identified valves for controlling water and chemicals. (Figure 8-10)

Equip each cleaning station with 50 to 75 feet of high-pressure water hose and hose racks or automatic hose reels. These hoses must be able to handle high water pressure as well as withstand high temperatures and the caustic or acid effects of chemicals used in the system. Hoses must also be resistant to lubricants and oils found in many areas waiting to be cleaned.

Although not imperative, it is a good idea to equip the cleaning station with a direct-reading temperature gauge.

### APPLICATOR GUNS/NOZZLES

Choose applicator guns and spray nozzles to accommodate the pressure conditions of the system. (Figure 8-11) These guns are available with wands of different lengths. Many come with automatic (fail-safe) shut-off features which are highly recommended. Applicator guns constructed of corrosive-resistant materials for use with highly corrosive cleaning chemicals are the best choice. Nozzles are available in a variety of spray patterns. A spray pattern of 15° will satisfy most cleaning jobs. Nozzles ranging from 0° to 40° and wider may be required for special jobs. The nozzle orifice is important in obtaining the desired flow rate at the design pressure. Many high-pressure systems are designed to produce the required pressure six inches from a nozzle with a 15° spray pattern. At a distance of twelve inches,

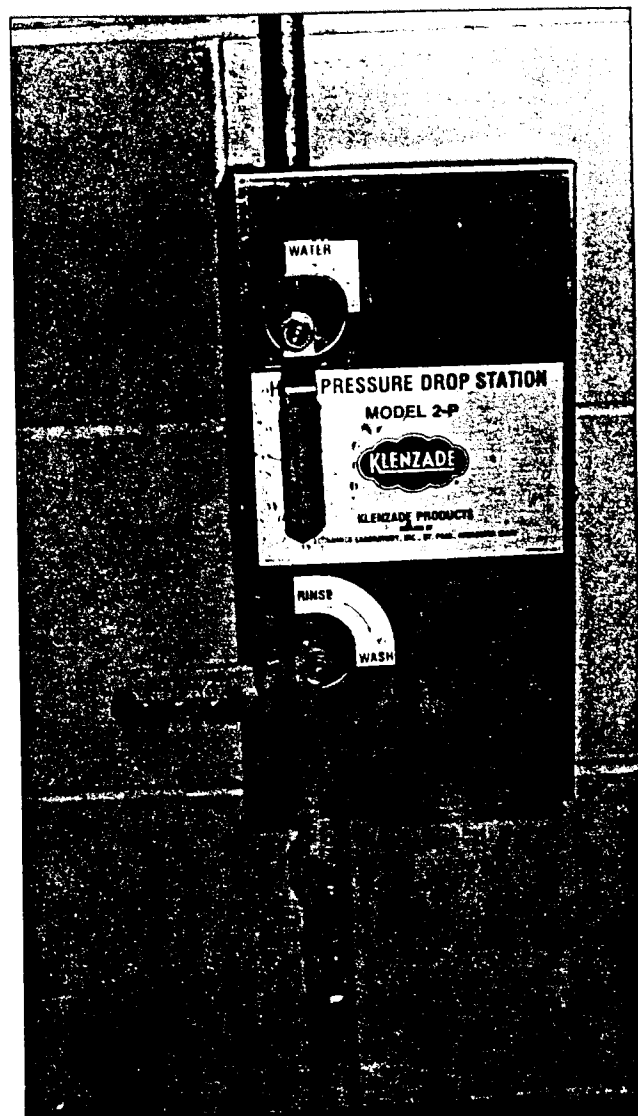


FIG. 8-10 Hose stations; note the clearly identified valves.

the pressure drops to approximately one half; and at eighteen inches, to approximately one quarter of the design pressure.

High-pressure low-volume systems need adjustable nozzles that can be easily adjusted to suit the cleaning requirement. A multiple spray pattern selection nozzle that offers several angles of spray (such as 0°, 15°, and 40°) and a selection of different orifices may be worthwhile if the cleaning tasks are somewhat different. Orifice size selection features allow chemicals to be applied at low pressures, which is desirable for eliminating splash back and chemical waste.

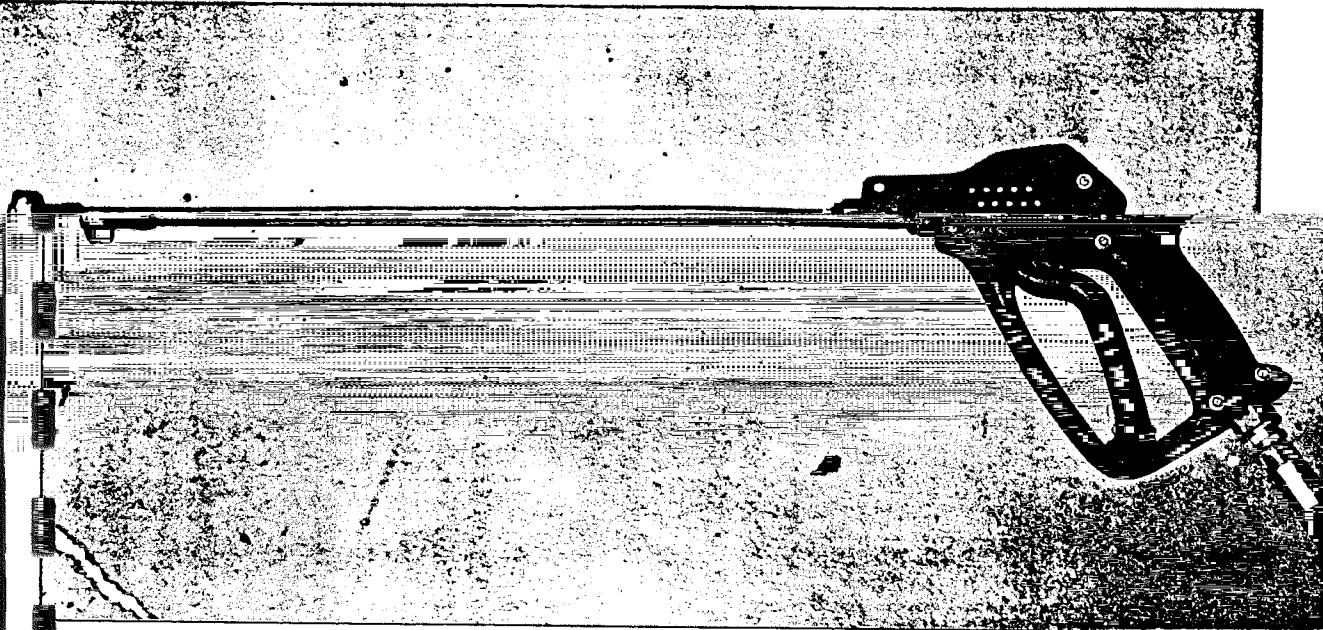


FIG. 8-11 A cleaning gun assembly with a fail-safe water valve automatically closes when the trigger is released.

### CHEMICAL FEEDERS

As previously mentioned, chemicals can be added in several places: at a central mixing point, from which they are distributed to the use points, or specifically at the use points. Chemical feed pumps can be used to dispense chemicals into the system, or a simple Venturi valve can be used to siphon the chemicals into the system. Chemical feed pumps should be considered when accuracy is important. (Figure 8-12) Venturi valves require a flow control orifice or flow control valve to regulate the chemical quantity. Orifices can be easily changed as indicated by the chemical requirements.

Remember that whenever chemicals are added to a potable water system, backflow prevention equipment will be needed to prevent contamination of the water system.

### HOT WATER SUPPLY UNITS

Hot water supply units are the backbone of the central system. (Figure 8-13) It is essential to have a system that can dependably supply an adequate amount of hot water at the proper pressure. Hot water units can be direct gas fired, electric, or steam heated. Small gas-fired hot water boilers or large water heaters should be considered if cleaning activities are planned for production downtimes. This eliminates running larger boilers just to provide hot water for cleaning.

The size of the hot water heating units will depend

on the number of cleaning stations to be operated at any one time. Give careful consideration to this in order to ensure satisfactory performance. Operating more stations than specified will result in a hot water supply problem.

The hot water supply units should be installed in enclosed areas with adequate space for servicing. Boiler rooms or areas near boiler rooms are desirable.

### FOAM AND JELL

Foam and jell applicators can be added to central cleaning systems. These applicators require special foaming and jelling detergents and compressed air at around 60 to 90 psi, which is used as the expelling agent. The foam and jell materials virtually encapsulate the cleaning detergent, trapping or holding it against the surface to be cleaned and allowing it to do its cleaning work through soil breakdown. (Figure 8-14) The length of time this takes depends largely on the toughness of the soil and the strength of the cleaner. Once the surface is considered clean, the foam or jell material is rinsed off with clear water.

### INDIVIDUAL HOT WATER HOSE STATION

Although different from a central cleaning system in size, for all practical purposes, the individual hot water hose

station is very similar to the central system. The individual hot water hose station can be high pressure or low pressure. It can consist of the same components found in a central system or of specially designed water or water/steam mixing equipment. In this section we will discuss primarily the

specially designed equipment.

The individual low-pressure, high-volume hot water hose station utilizing steam/water mixing valves offers one of the more economical ways to provide hot cleaning water at a given location in the plant. This station is particularly

FIG. 8-12 A chemical feed pump can assure chemical accuracy.

